Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

1010 EMPIRE BUILDING | JULY, 1945 | PITTSBURGH, PA.

The WEAN

ENGINEERING CO., Inc. - - WARREN, OHIO

Subsidiary Company
The Broden Construction Company
Cleveland, Ohio

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DETROIT

LOOK TO TOMORROW'S HORIZON

Mighty symbol of current development that will serve a world at peace is the giant skybird, "Mars"

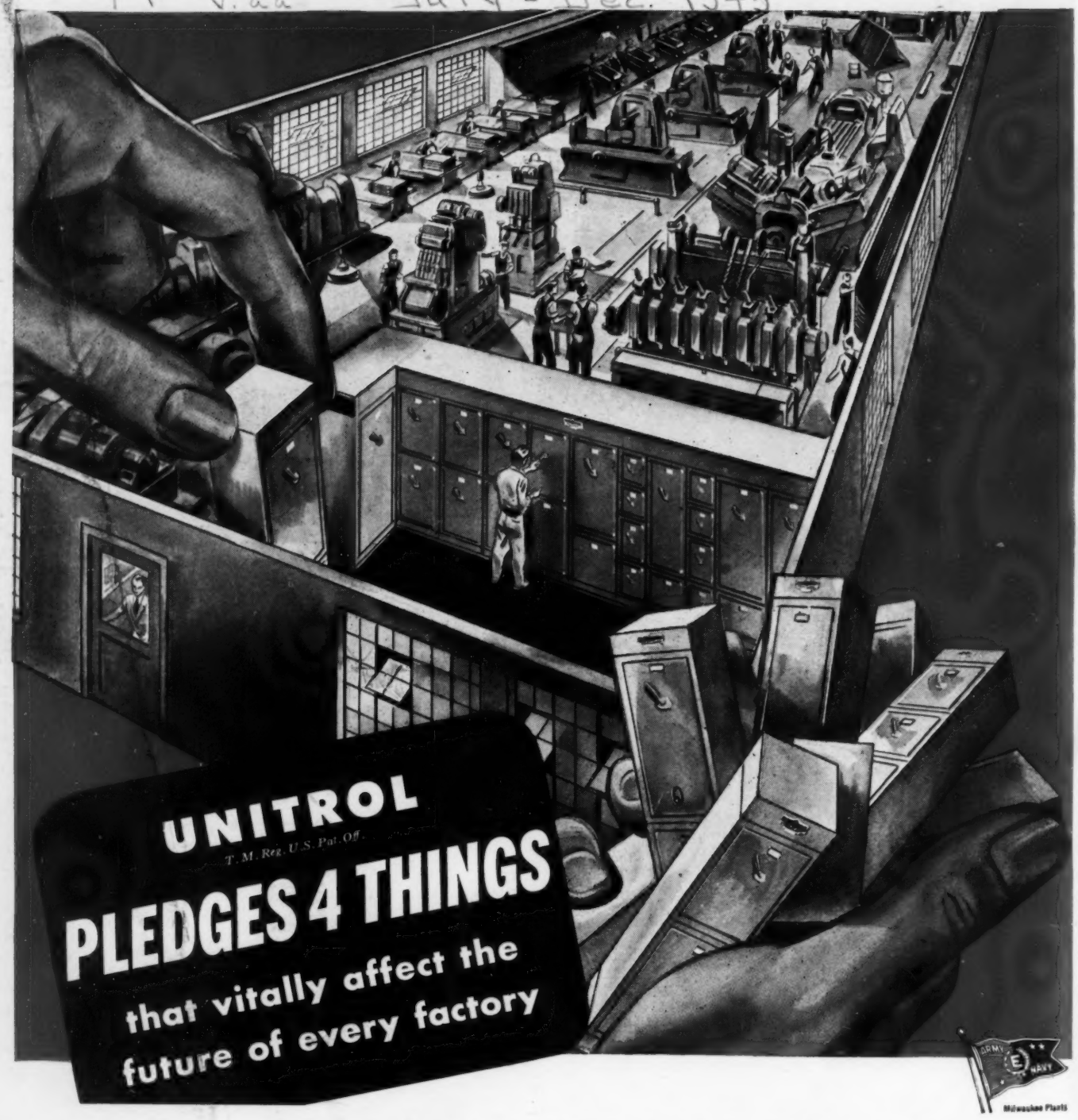
So Wean Engineering has become a symbol of today's achievements ready to meet tomorrow's demands in the field of sheet, strip and tin mill designing and manufacturing. Wean-designed, Wean-built equipment has brought increased output with greater efficiency, fewer costly breakdowns, more economy of operation. Important today! Yes, vastly so, but *vitally necessary* in the highly competitive days to come.

Men of steel who are looking to the horizons of tomorrow look to Wean Engineering.

THE WEAN ENGINEERING CO., INC.
WARREN, OHIO

SPECIALISTS IN SHEET, STRIP AND TIN MILL EQUIPMENT

R v.22² July-Dec. 1945



These things *some* factories knew before; these things the war *proved* beyond all doubt; these things *most* production men will never forget:

- A factory must always be able to convert its production facilities quickly and easily to utilize improved methods or to meet changing demands;
- It must reduce to a minimum the non-productive time of men and machines;
- It must fit equipment ever closer to the convenience and safety of workers;
- It must conserve floor space without creating congestion.

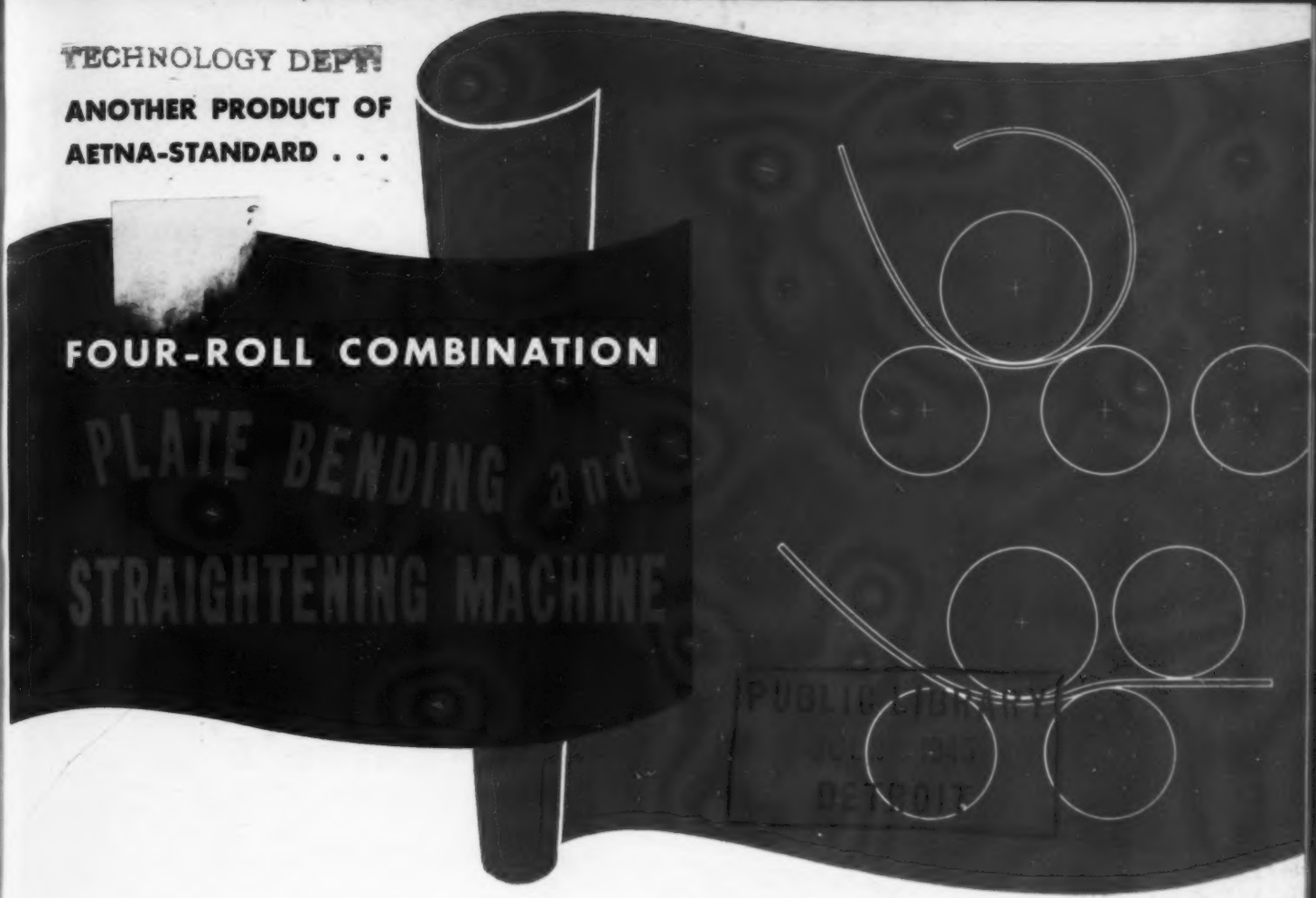
So, hundreds of progressive factories are buying or planning to buy UNITROL. For UNITROL, the better system of housing and installing motor control, is also the means of keeping motor control ready for the unpredictable shifts of the future. UNITROL reduces non-productive time in the inspection and servicing of motor control. UNITROL centralizes motor control so compactly that all control can be brought almost within arm's length of the serviceman. UNITROL "brings the work to the worker" . . . the elements are accessible, convenient, easy to change or replace. UNITROL makes it virtually impossible to overlook any control during routine inspection, promoting systematic, rapid, thorough attention. UNITROL, the factory-assembled, factory-wired motor control center that saves costly preparation and space, and is so easy to expand, contract and "convert," is one of the outstanding contributions to industrial progress and efficiency. Ask for the FREE book on UNITROL today. CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.

CUTLER-HAMMER
UNITROL
C-H

Tech

TECHNOLOGY DEPT.

ANOTHER PRODUCT OF AETNA-STANDARD . . .



Here's a machine which can be used for either bending or straightening of plates. By merely pressing the push-button control, an operator can convert the unit from 3-roll bending to 4-roll straightening *in a matter of seconds.*

Thus, when a curved plate needs to be straightened and recurved, the operator can do the complete operation without removing the plate from the machine.

Another feature is the ease with which a closed plate can be taken off the rolls. The outboard bearing support *swings in and out of position.* This mechanism, controlled by the hand wheel, eliminates the necessity for lifting the bearing support on and off.

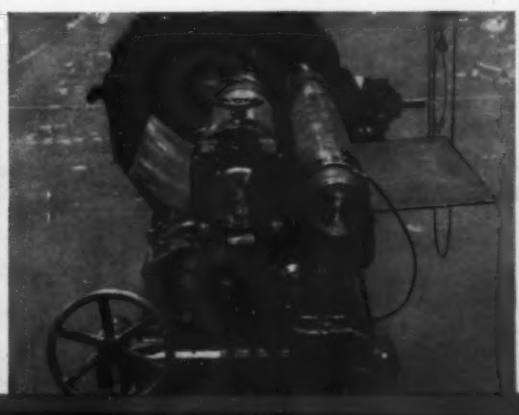
Other features of the Aetna design emphasize ease o operation and maintenance, such as the centralized grease system for all 9 bearings, the fully enclosed self-lubricating drive, and the rigid construction. Al rolls are connected to drives by flexible bearings o universal spindles.

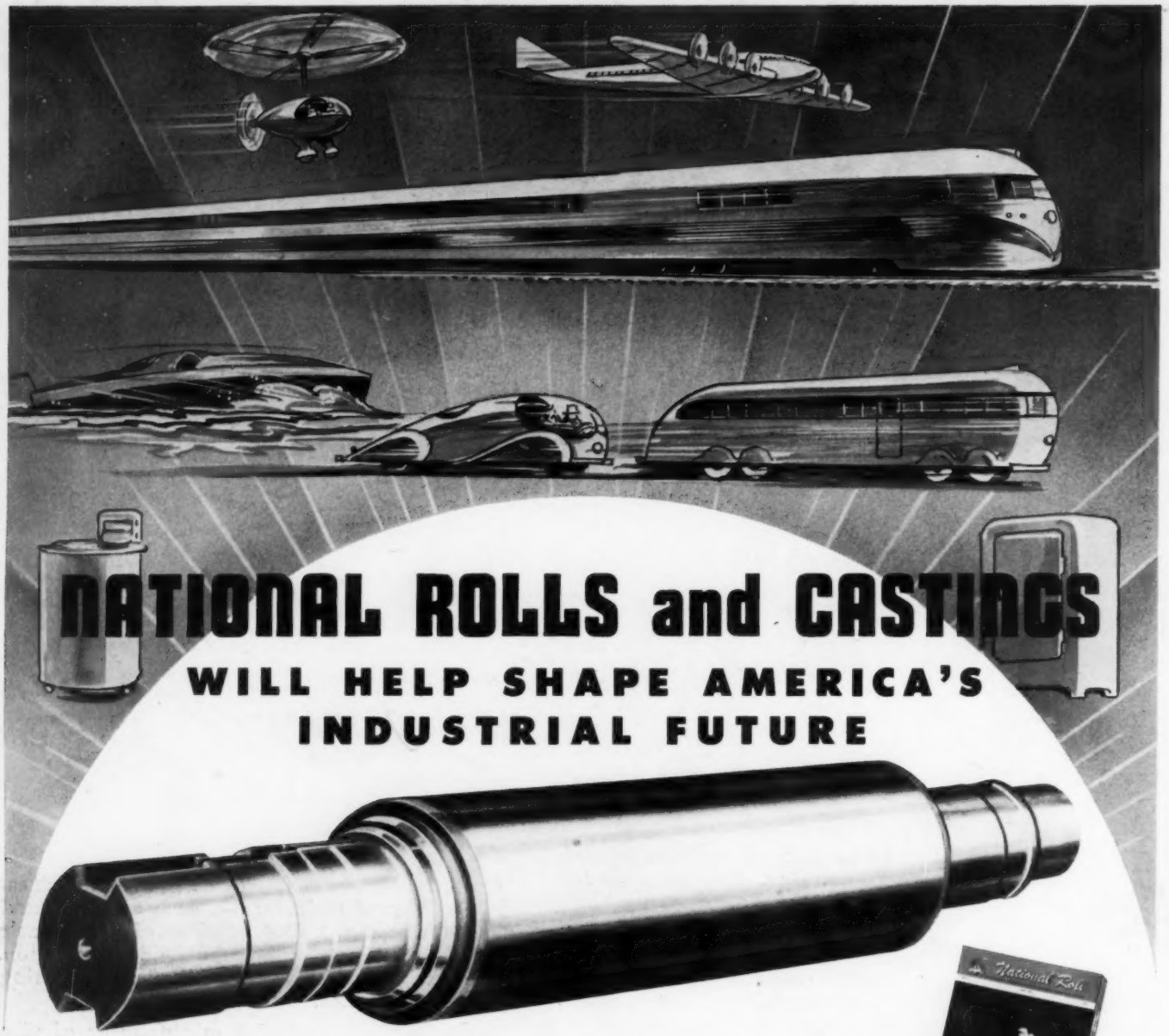
Aetna-Standard, exclusive manufacturer of piercing mills, builds 3-roll bending machines, in addition to 4-roll bending and straightening machines; also 2 high and 4-high sheet and plate levellers and many other products for the steel and non-ferrous industries

THE AETNA•STANDARD
ENGINEERING COMPANY
YOUNGSTOWN, OHIO

DESIGNERS AND BUILDERS to the Steel, Non-Ferrous and Chemical Industries.

ASSOCIATED COMPANIES:
HEAD, WRIGHTSON & COMPANY, LIMITED, THORNABY-ON-TEES, ENGLAND
JOHN INGLIS COMPANY, LIMITED, TORONTO, ONTARIO, CANADA





NATIONAL ROLLS and CASTINGS

WILL HELP SHAPE AMERICA'S INDUSTRIAL FUTURE

Tomorrow's pent-up needs spur the imaginative thinking of today. On countless drawing boards streamlined, sales-appealing designs are taking form. In research laboratories radical mechanical advances are being put through their paces. Yes, great developments are just ahead —only awaiting the war's end for release to a hungry market.

In most of these developments metal, in some form, will be basic. At National, we both work with metal and also produce metal working equipment. We have modern facilities for the large volume production of heavy iron and steel castings. We make all grades of iron and alloy iron; plain carbon and alloy steel rolls.

We, too, are thinking ahead of the times. *Yes, keep an eye on National!* We look for our program of research and development, expanded and intensified during the present emergency, to contribute many gains for peacetime application.

IS YOUR NAME ON THE MAILING LIST FOR THE *National Roll?*

The National Roll is a publication, issued quarterly, and devoted to the metallurgy, production and use of cast rolls, iron and steel castings. Management, engineers, and operating men in the steel industry will find its pages carry much of interest. If you would like to receive this paper regularly, write us and we will gladly add your name to the mailing list.

NATIONAL ROLL & FOUNDRY CO.

AVONMORE, PENNSYLVANIA

Manufacturers of: ALL GRADES OF CAST ROLLS • IRON & ALLOY IRON STEEL & ALLOY STEEL • HEAVY IRON & STEEL CASTINGS • ROLLING MILL EQUIPMENT

HOW TO PUT NEW LIFT LIFE IN OLD CRANES

Cranes stay in service longer than most other equipment; but after long-time service, production needs usually outstrip the lifting power or speed of the older cranes.

Alliance engineers rejuvenate these old faithfuls to fit current or future needs. For instance, we may be able to increase or decrease the span, change hoist arrangement, install new power units, or relocate a crane to gain more lifting power or speed for your plants. These or other changes will make new cranes out of old.

Check with Alliance about reconverting the old cranes in your plant.

This 120-ton gantry crane built by Alliance has one of the highest lifts on record—255 feet. The crane is used for regulating the conduit emergency gate and radial gates on the Hiwassee Dam of TVA.

Whether you need new cranes or want to increase lifting power of old cranes, check with Alliance, world's largest builders of the world's largest cranes.

Alliance

LADLE CRANES . GANTRY CRANES . FORGING MANIPULATORS
SOAKING PIT CRANES . STRIPPER CRANES . SLAB AND BILLET
CHARGING MACHINES . OPEN HEARTH CHARGING MACHINES

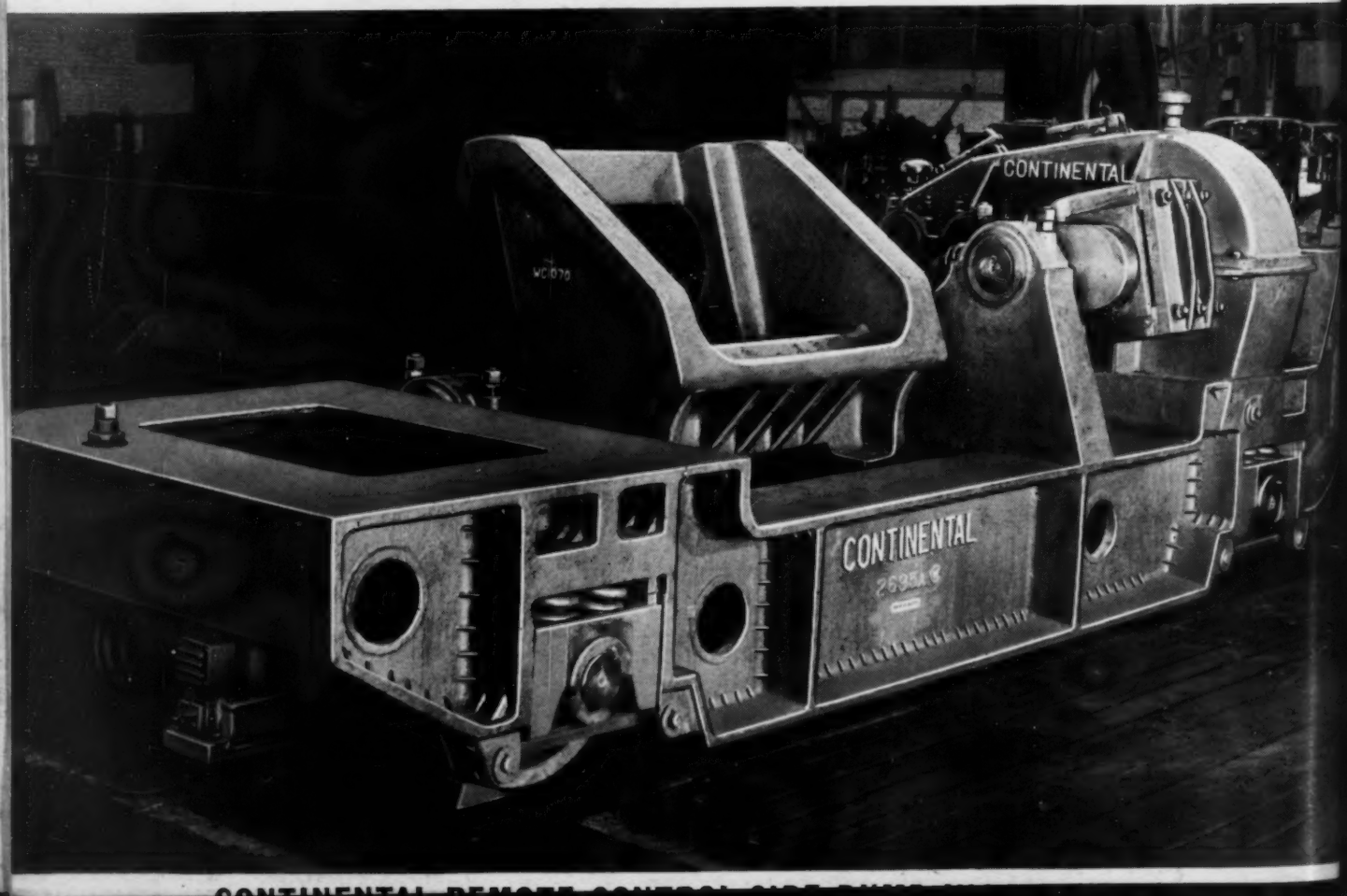
THE ALLIANCE MACHINE COMPANY • ALLIANCE, OHIO

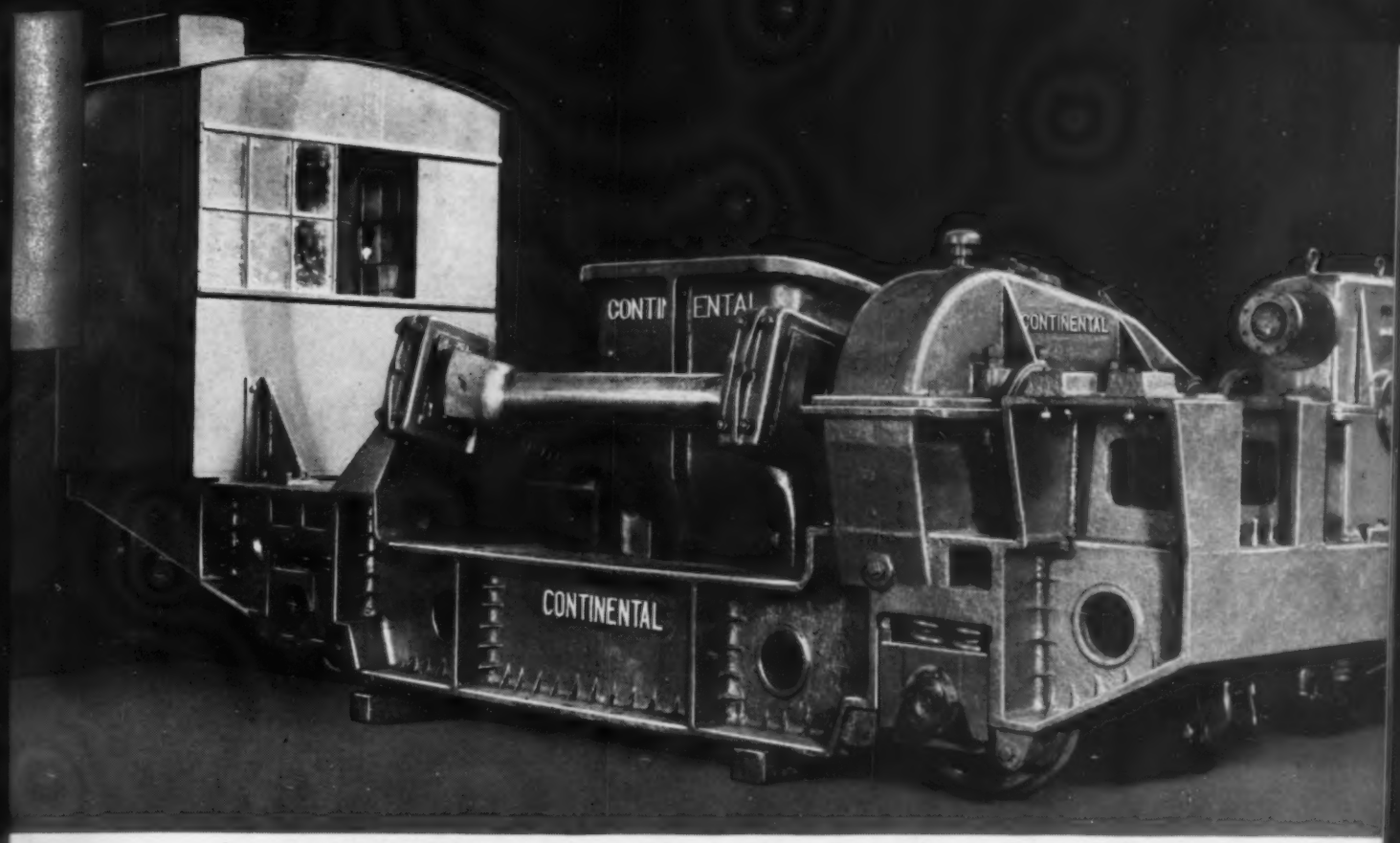
PITTSBURGH OFFICE : 1622 OLIVER BUILDING

INGOT BUGGIES

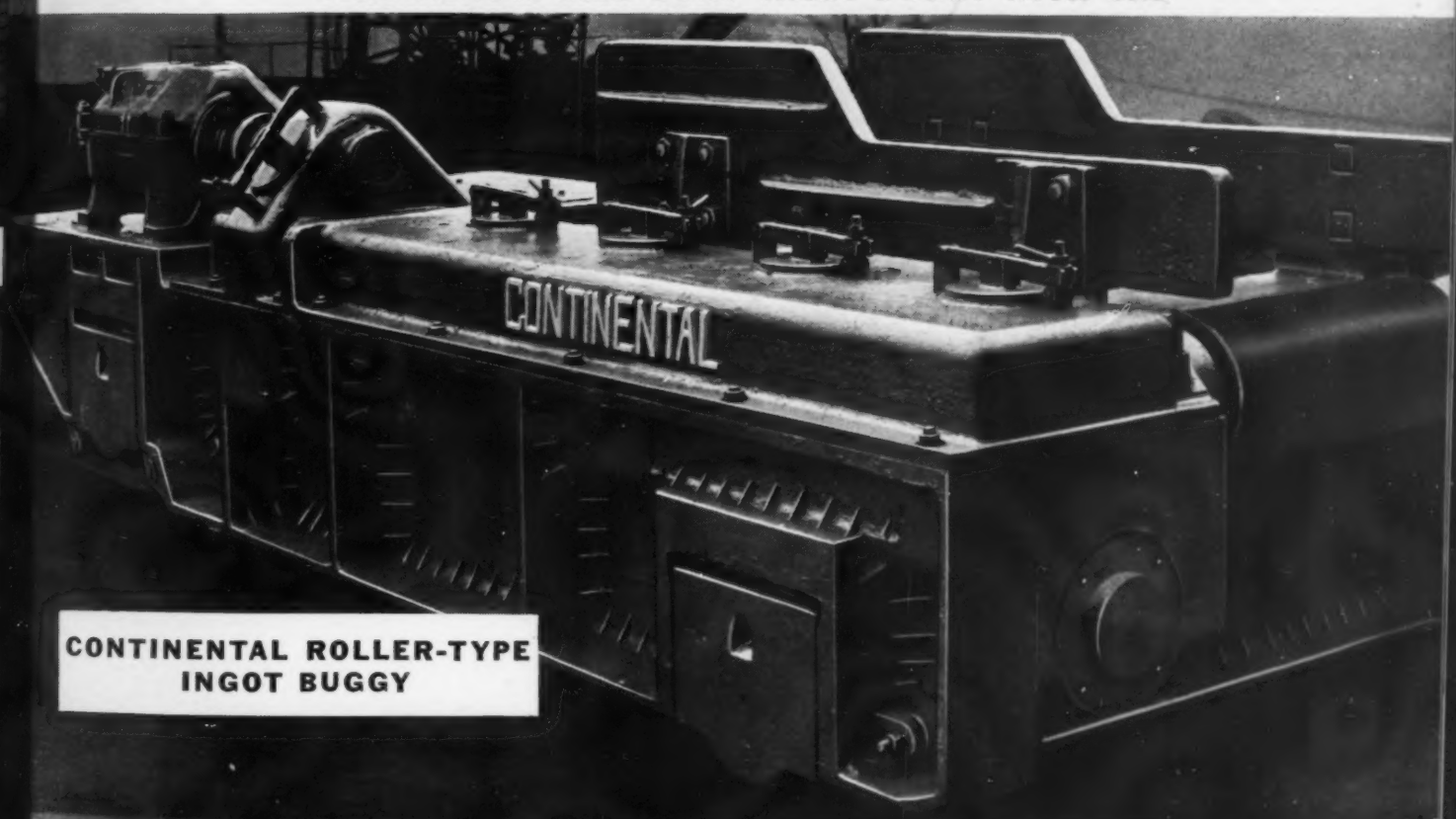
DESIGNED AND BUILT BY CONTINENTAL

CONTINENTAL END DUMP INGOT BUGGY





CONTINENTAL SIDE DUMP INGOT BUGGY WITH CAB



CONTINENTAL ROLLER-TYPE INGOT BUGGY

CONTINENTAL

FOUNDRY & MACHINE COMPANY

CHICAGO • PITTSBURGH

Chicago Works
East Chicago, Ind.

Pittsburgh Works
Coraopolis, Pa.

Wheeling Works
Wheeling, W. Va.

Norwood Works
Wheeling, W. Va.

TYPE WB BRAKE

Solves the A-C BRAKE Problem

. . . . gives better PERFORMANCE too...

Rectifier - Unit in compact form for separate mounting on existing installations.

MANY users of a.c. motor-driven cranes, hoists and machinery are switching to the EC&M Type WB Brake with rectifier-unit. Its *high-speed performance* and *reduced up-keep* for a.c. circuits have prompted its nationwide acceptance. Repeat orders indicate standardization on the WB Brake wherever a.c. brakes are needed.

These brakes not only eliminate the laminated members required in a.c. brake design, but give quick response. High initial current insures *fast release;* automatic reduction of the holding current results in *fast setting.*

The rectifier-unit is compact and is arranged for separate mounting for existing installations. On new projects, it may be combined with the motor control panel. Bulletin 1006 gives complete details on WB Brakes for a.c. operation. Bulletin 1004-D describes them for d.c. service.

THE ELECTRIC CONTROLLER AND MANUFACTURING CO.

2698 East 79th Street — Cleveland 4, Ohio

REDUCED UP-KEEP *and* BETTER OPERATION

because

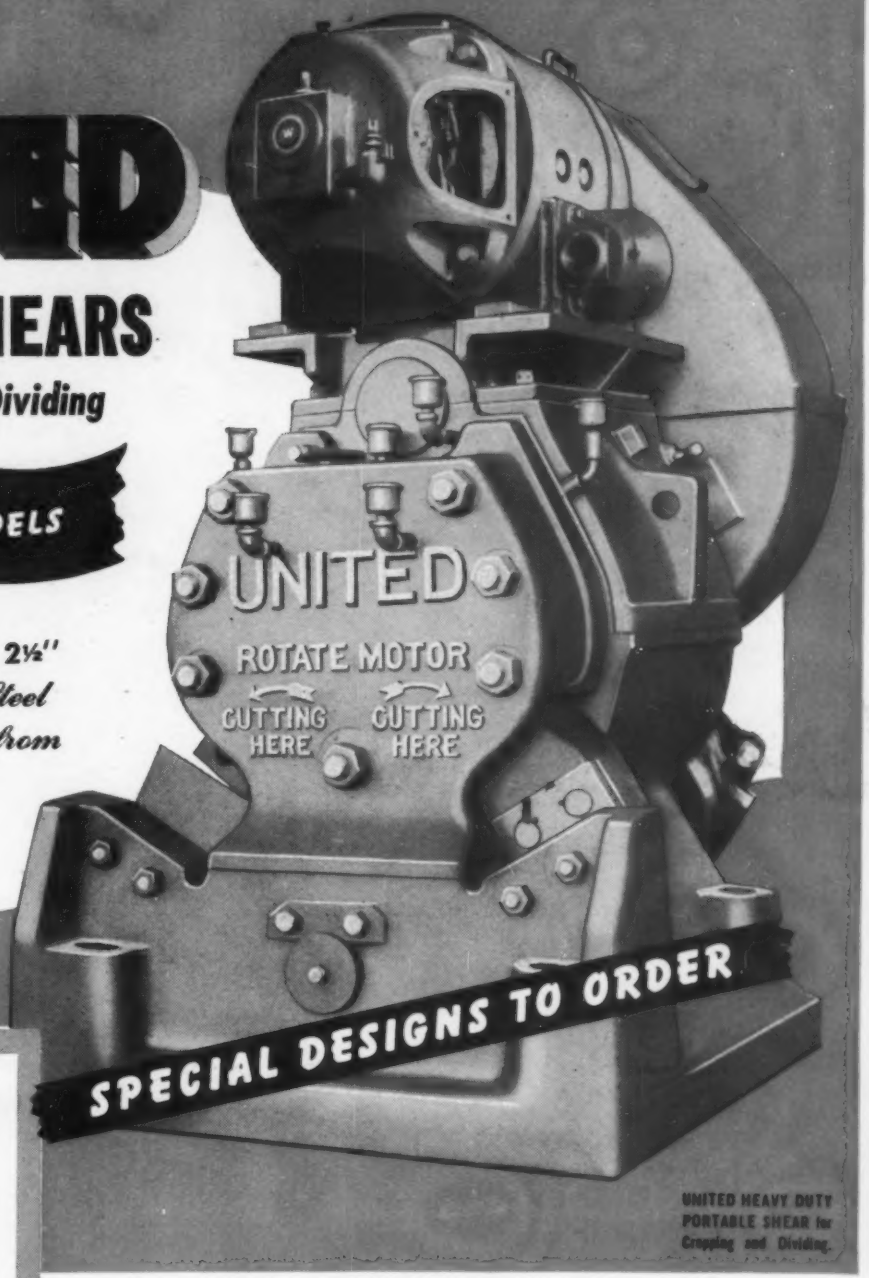
No laminated magnets or plungers.
No destructive hammer-blow.
No a.c. chatter.
No coil burn-out due to shoe-wear affecting air-gap.
No motors, gears or pumps.
Has fast release and fast set.
Has ability to permit accurate inching.
Has hand release.
Has solid cast-steel magnet and armature.
Has short armature-movement.
Has thick, molded brake blocks 1/4" to 3/4" thick.

On Cranes, Hoists and Machinery ...the EC&M Type WB Brakes *give* HIGH SPEED PERFORMANCE —REDUCED UP-KEEP

UNITED
PORTABLE SHEARS
For Cropping and Dividing

5 STANDARD MODELS

Capacities to 2½" Square Hot Soft Steel at Temperatures from 1200° F. *to* 1400° F.



UNITED HEAVY DUTY PORTABLE SHEAR for Cropping and Dividing.

OUTSTANDING FEATURES

- Low First Cost
- Rugged, Compact Construction
- Economical Maintenance
- All Mechanical Parts Fully Enclosed
- Furnished for Either Right Hand or Left Hand Operation
- May Be Used also for Cold Cutting Lighter Sections
- Occupies Only 24" x 24" Floor Space

UNITED PORTABLE SHEARS are designed especially for uses where the need does not justify a large investment, but where production capacity is increased by having a small shear available.

More than 40 units are at present contributing to the economical operation of merchant mills in plants throughout the United States and foreign countries.

UNITED engineers will gladly recommend a suitable shear for *your* requirements. Consult us freely.

UNITED ENGINEERING AND FOUNDRY COMPANY
PITTSBURGH, PENNSYLVANIA

Plants at Pittsburgh · Vandergrift · New Castle · Youngstown · Canton
Subsidiary: Ademson United Company, Akron, Ohio
Affiliates: Davy and United Engineering Company, Ltd., Sheffield, England
Dominion Engineering Works, Ltd., Montreal, P. Q. Canada

The World's Largest Designers and Makers of Rolls and Rolling Mill Equipment

THE 2-JOB OIL

DRUMS! DRUMS! DRUMS!
War needs make it extremely important that all empty drums be returned immediately.

TYCOL

TYCOL INDUSTRIAL

ENGINEERED FOR EVERY

THAT DOES *Both Jobs Better*

TYCOL

DUAL PURPOSE OIL

Yes, you use only *one* oil for *both* cutting and machine lubrication, and you get better results both ways.

Better cutting performance because Tycol "Dual Purpose" increases speeds, feeds, and tool life . . . minimizes build-up on cutting tools.

Better machine lubrication, too, because this unique oil gives thorough protection to gears and bearings . . . and it won't corrode nor harmfully affect ferrous or non-ferrous metal parts.

What's the reason for this two-way superiority? Tycol Dual Purpose Oil contains precisely enough sulphur for high speed cutting, but the sulphur is in *combined* form. It won't separate, won't filter out. That's what makes Tycol Dual Purpose such an effective lubricant for automatics and other machines, as well as an exceptional cutting oil.

Why not see for yourself how Tycol Dual Purpose can step up cutting speeds and improve machine performance in your plant? For complete information call or write any Tide Water Associated office.

FREER CUTTING, LONGER TOOL LIFE

By minimizing build-up on cutting tools, Tycol "Dual Purpose" permits faster cutting — lengthens tool life between grinds.

PROTECTS BEARINGS AND GEARS

Won't corrode, or harmfully affect copper or copper alloy machine parts. Result — lower maintenance costs.

EXCELLENT WITH CARBIDE TOOLS

Tycol "Dual Purpose" brings out the best cutting performance of carbide tools, without attacking the binder.

LUBRICANTS
SERVICE NEED

TIDE WATER ASSOCIATED OIL COMPANY
17 BATTERY PLACE · NEW YORK 4, N. Y.

PRINCIPAL OFFICES
BOSTON · PHILADELPHIA
PITTSBURGH · CHARLOTTE, N. C.
TIDE WATER OIL COMPANY OF CANADA, LTD.
TORONTO · MONTREAL

Pioneered by North American

LUMINOUS OR LONG FLAMES with either gas or oil are produced by the Series 113 Burners. They are desirable for vast coverage, for fewer burners and for uniformity of flame temperature.

SHORT FLAMES are produced by the Series 221 Burners. These burners provide a highly stable and efficient fire, using either gas or oil. They are recommended wherever heating in a relatively small space is required.

WRITE FOR DESCRIPTIVE LITERATURE

DUAL-FUEL BURNING SYSTEMS FOR GAS AND OIL

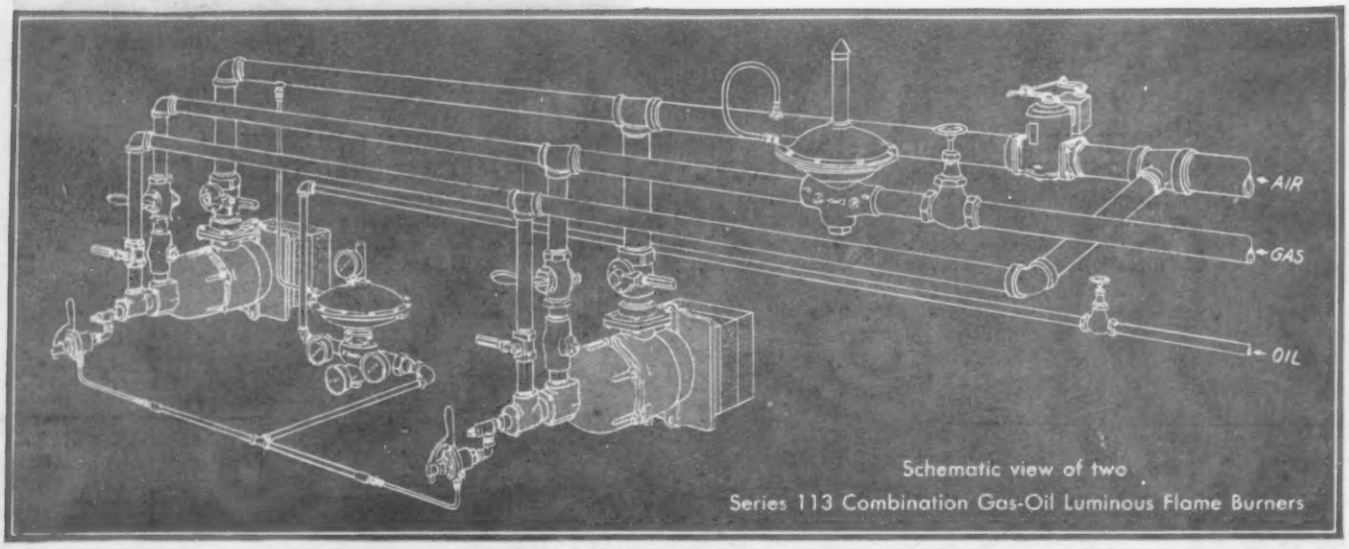
MAXIMUM EFFICIENCY WITH EITHER FUEL—designed especially for gas and for oil.

SWITCH FUELS INSTANTLY—no change required in piping or burner inserts.

AUTOMATIC FUEL-AIR PROPORTIONING—one air valve controls the fire of one or a battery of burners regardless of the fuel being burned.

WIDE TURNDOWN RANGE—no "flash back" possible.

THE NORTH AMERICAN MANUFACTURING COMPANY
MANUFACTURERS OF INDUSTRIAL FUEL BURNING EQUIPMENT FOR GAS OR OIL
BRANCH OFFICES with FIELD ENGINEERS in PRINCIPAL CITIES
CLEVELAND 4, OHIO



Schematic view of two
Series 113 Combination Gas-Oil Luminous Flame Burners

THE MIGHTY SEVENTH—
Let's Put it Over!

MESTA ROLLS

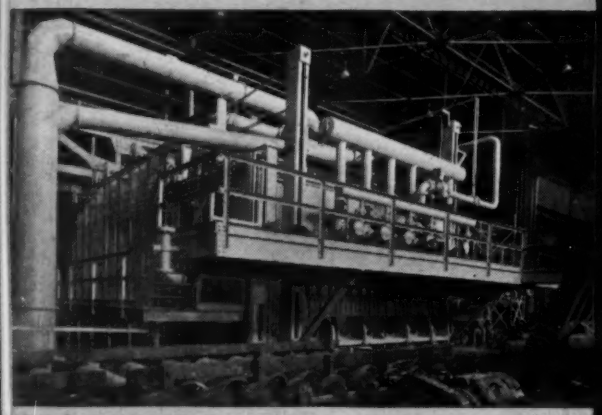
TURNING A MESTA SPECIAL ALLOY STEEL STRUCTURAL MILL ROLL USED IN PRODUCTION OF 4 INCH CHANNELS.

ARMY E NAVY

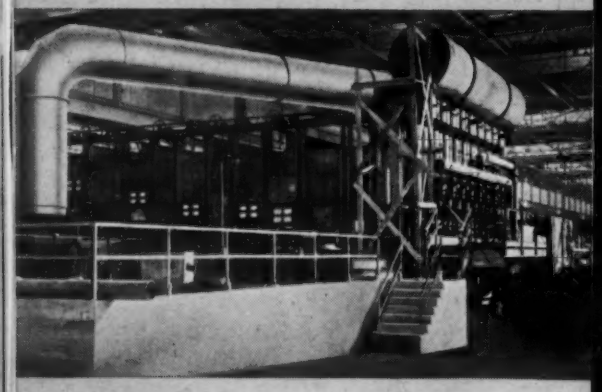
MESTA MACHINE COMPANY
PITTSBURGH, PA.

'SURFACE' SERVES WITH HEAT

"Surface" one-way fired soaking pits



"Surface" slab heating furnace



"Surface" billet reheating furnace

Surface" continuous heat treating furnaces for plate

FROM INGOT TO FINISHED PRODUCT

Hundreds of installations, including the modern One-Way Fired Soaking Pits... Slab, Billet and Round Heaters ...Continuous and Batch Normalizers and Annealers — Muffle-type and Radiant Tube Fired, Controlled Atmosphere Furnaces... give outstanding proof of "Surface" acceptance wherever heat is used in the Steel Industry.

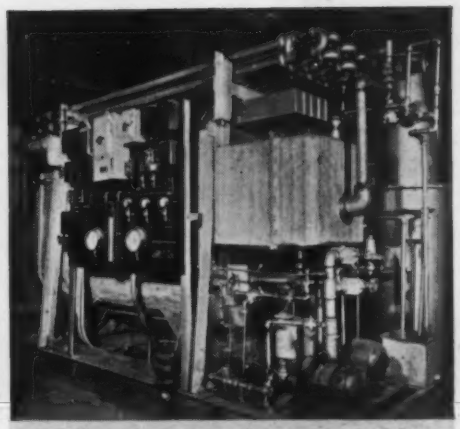
"Surface" collaboration with metallurgists and engineers in the metal producing and working industries, plus the years of constant laboratory research in the scientific application of gases, heat and mechanisms to the many heating problems, have resulted in continuous improvement in equipment to give the desired result. Only a few such installations are shown herewith, representative of "Surface" developments in the industry.

Now, when quality tonnage is paramount, "Surface" is ready with modern processes and methods to meet the world's demands.

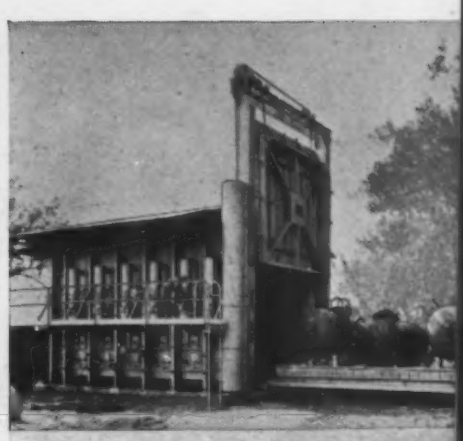
'Surface'

SURFACE COMBUSTION • TOLEDO 1, OHI

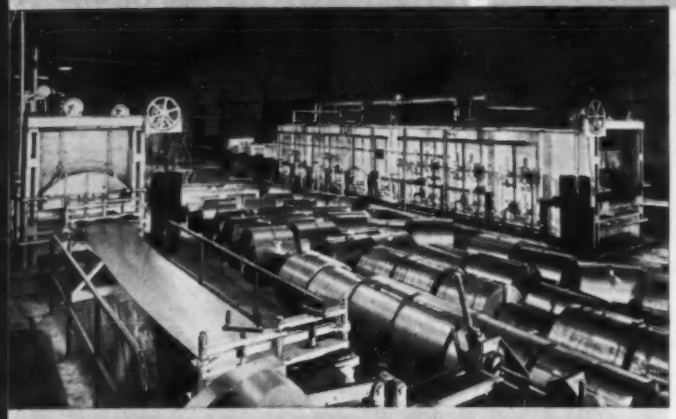
"Surface" rod annealing in pit type convection furnaces



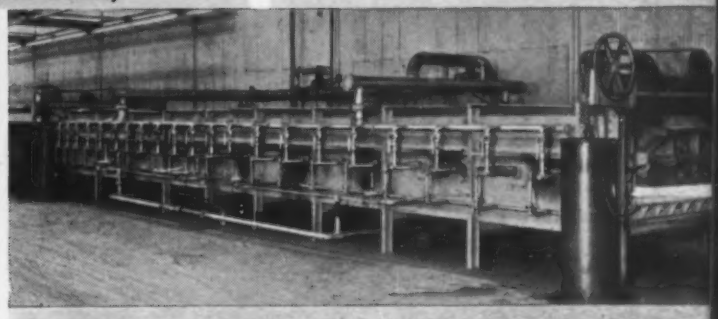
"Surface" prepared gas generating equipment (NX, RX, DX and Char-Mo Gases).



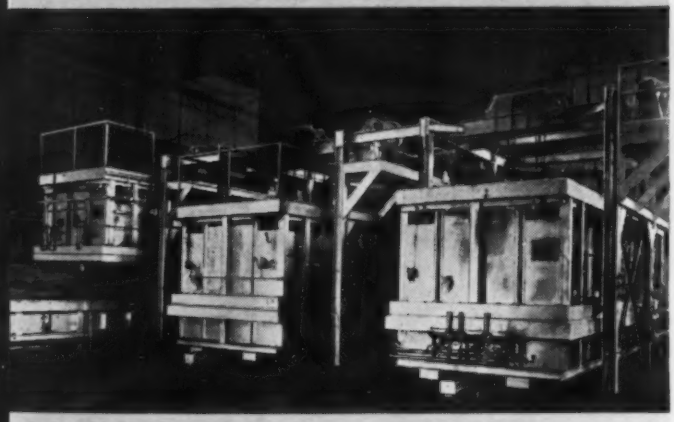
"Surface" stress relief furnace



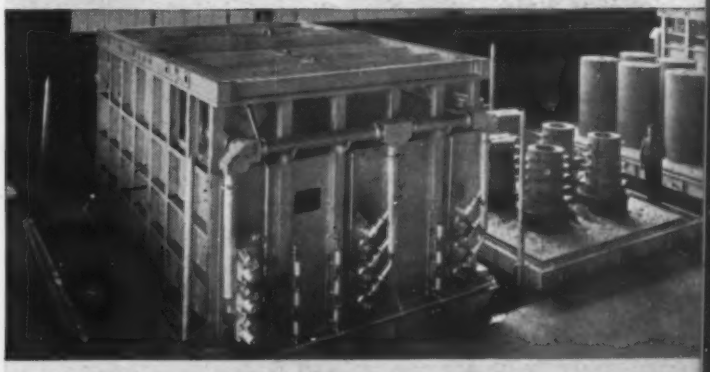
"Surface" continuous controlled atmosphere strip annealing and normalizing furnaces



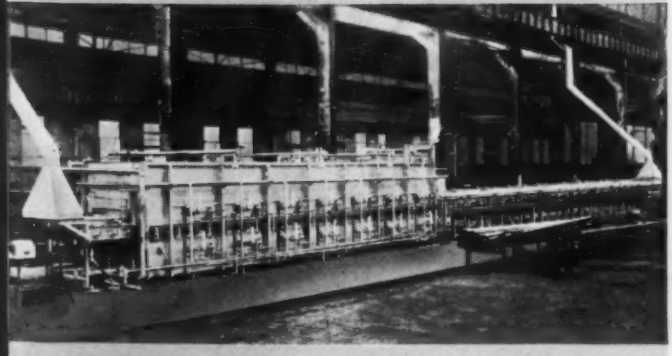
"Surface" wire patenting furnace



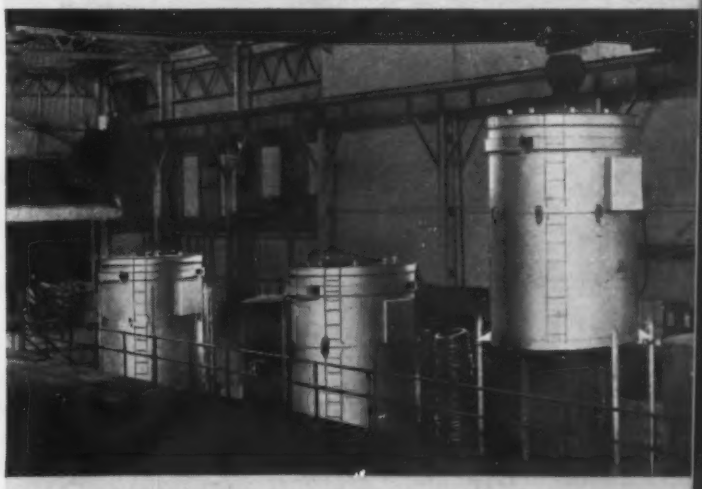
"Surface" high alloy rod and bar atmosphere annealing lift-cover with car-bottom furnace



"Surface" controlled atmosphere coil and sheet annealing cover



"Surface" bright annealing and normalizing furnace for tubing



"Surface" controlled atmosphere wire and rod annealing furnac

Shell Tempering Furnace and its Micromax Controllers; Cribben and Sexton Co., Chicago.

SHELLS Get Correct TEMPER-ature In This Micromax-Controlled Furnace

The tempering of shell forgings in the Chicago plant of Cribben and Sexton Company, peacetime manufacturers of Universal Gas Ranges, is quite a change from that Company's normal production; but the job of controlling the furnace temperature in this new work is a detail about which Cribben and Sexton has not hesitated.

The Company has "always" used Micromax Pyrometers to maintain uniform temperature of furnaces in which the enamelled parts of Universal Ranges are fired. The resulting uniformity of enamel is definitely a part of the high quality of the Universal line, and Cribben and Sexton knew that shell production could profit directly by Universal standards of dependable uniformity. Therefore, Micromax Pyrometers regulate both hardening and tempering of shells, and results are uniformly excellent.

V depends on me!
A Slogan For Every American

Ability to stay dependably on the job is probably the chief quality which makes Micromax so good for busy, war-rushed plants. It normally runs for days at a time with no attention at all, and then five minutes' servicing starts another cycle. And the fact that the Controller is available in 5 models enables the specifier to select one to meet his particular need.

Catalog N-33A describes Micromax Pyrometers for thermocouples and will be sent on request, but if you have a problem in temperature control now before you, an L&N engineer will be glad to send such additional data as you require.

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Jrl Ad N-33(50)

HOW MANY CUBIC FEET *Do You Need?*

The efficiency of your plant cannot be judged by how *little* compressed air it uses each shift. What really counts is how *much* it uses, because every cubic foot of compressed air, properly applied, will increase your output and lower your costs. You need enough to do the jobs that can be done *only* by compressed air, and to do all of the other jobs that can be done *better*, *faster*, and *cheaper* by compressed air than by any other form of power.

You can save money, too, by selecting and installing the most economical compressors. For air power at pressures from 80 to 110 pounds per square inch, Ingersoll-Rand builds hundreds of types and sizes ranging from 1 to 15000 cubic feet per minute. These require from ½ to 3000 horsepower, and are driven by electric-motor, steam-, oil- or gas-engines.

No matter how many cubic feet you need, an Ingersoll-Rand Service Engineer can probably help you improve your present plant, and help select the best machines for any additional capacity that you may need.

Ingersoll-Rand

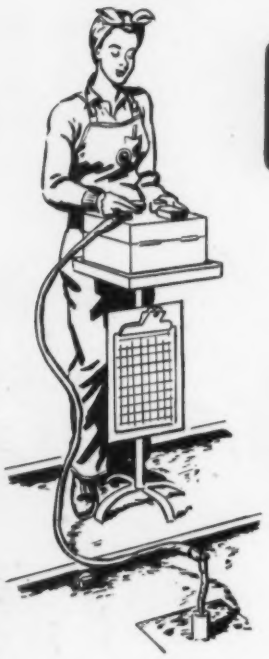
11 BROADWAY, NEW YORK 4, N. Y.

1-578

COMPRESSORS AND AIR TOOLS BUILT AND APPLIED BY THE MEN WHO KNOW AIR POWER

Number 10 of a Series: **"Looking at the 5 essential things you never see in electrodes!"**

Unforgettable EXPERIENCES!



ADDED TOGETHER, the working years of a faithful group of 369 National Carbon Company employees exceed 70 *centuries* of unforgettable experiences! *And unforgotten manufacturing experience* . . . with "National" carbon and "Acheson" graphite electrodes for electric furnaces. These loyal workers have been associated with us from 15 to 35 years each.

Now in its 60th year, National Carbon looks at the record of this group, and the many hundred others who have contributed so much to its history.

Some have improved plant machinery, or perfected its use. Others have developed formulas to yield stronger electrodes, or to give them lower electric resistance. Still others have helped customers use electrodes more effectively. A complete list of such achievements would be long indeed!

We truly believe that this unmatched manufacturing experience, extending over six decades, is of utmost importance to the quality of furnace electrodes . . . one of "the five essential things you never see" in them but which are basic to our products. The other "unseen" essentials are: Selection of raw materials, manufacturing control, customer service, and continuing research. Your inquiries are cordially invited.

NATIONAL CARBON COMPANY, INC.
Unit of Union Carbide and Carbon Corporation
UCC
GENERAL OFFICES: 30 East 42nd Street, New York 17, N.Y.
DIVISION SALES OFFICES: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco
In Canada: Canadian National Carbon Company Limited, Toronto 4, Canada

The registered trade-marks "National" and "Acheson" and the "National" and "Acheson" Seals distinguish products of National Carbon Company, Inc.

KEEP YOUR EYE ON THE INFANTRY . . . THE DOUGHBOY DOES IT!

Cut slag-handling costs – use

Johnston

BLAST FURNACE AND OPEN HEARTH TYPE

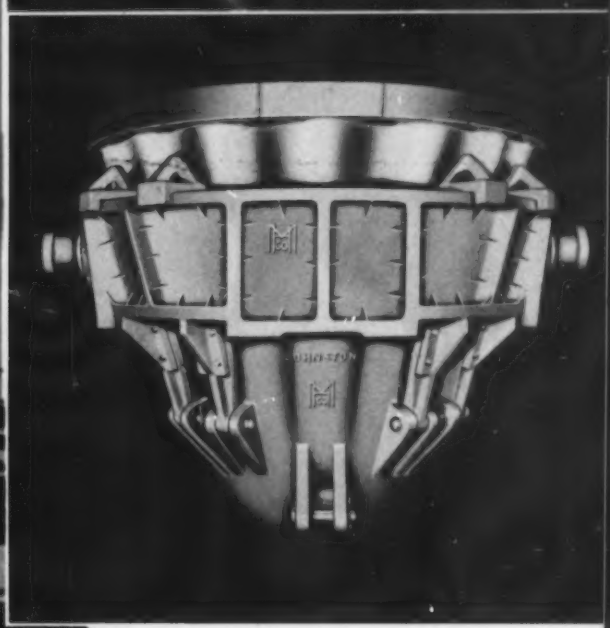
cinder pots

We don't sell "just castings"—we have no stock pots—Each Johnston Corrugated Cinder Pot is individually engineered to a specific plant condition . . . and we keep complete records of the chemical, metallurgical and physical properties of every one of them—actual plant performance where it's available.

We don't know *all* the answers but we *do* manage to lick a lot of problems. Our expanding rim (cast integral) for instance is generally acknowledged to be the most important cinder pot development since the advent of the Johnston Pot Support. This and other improvements has resulted in a 100% adoption of the Johnston Pot by an impressive number of leading plants . . . so we feel pretty certain that we can cut your slag-handling costs.

1803

Mackintosh-Hemphill Company is the exclusive licensee for the manufacture and sale of Johnston Patented Corrugated Pots and Supports.



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MACKINTOSH-HEMPHILL CO.

PITTSBURGH AND MIDLAND, PA.

P-G STEEL GRID *Resistors . . .* *for* HEAVY DUTY APPLICATIONS:

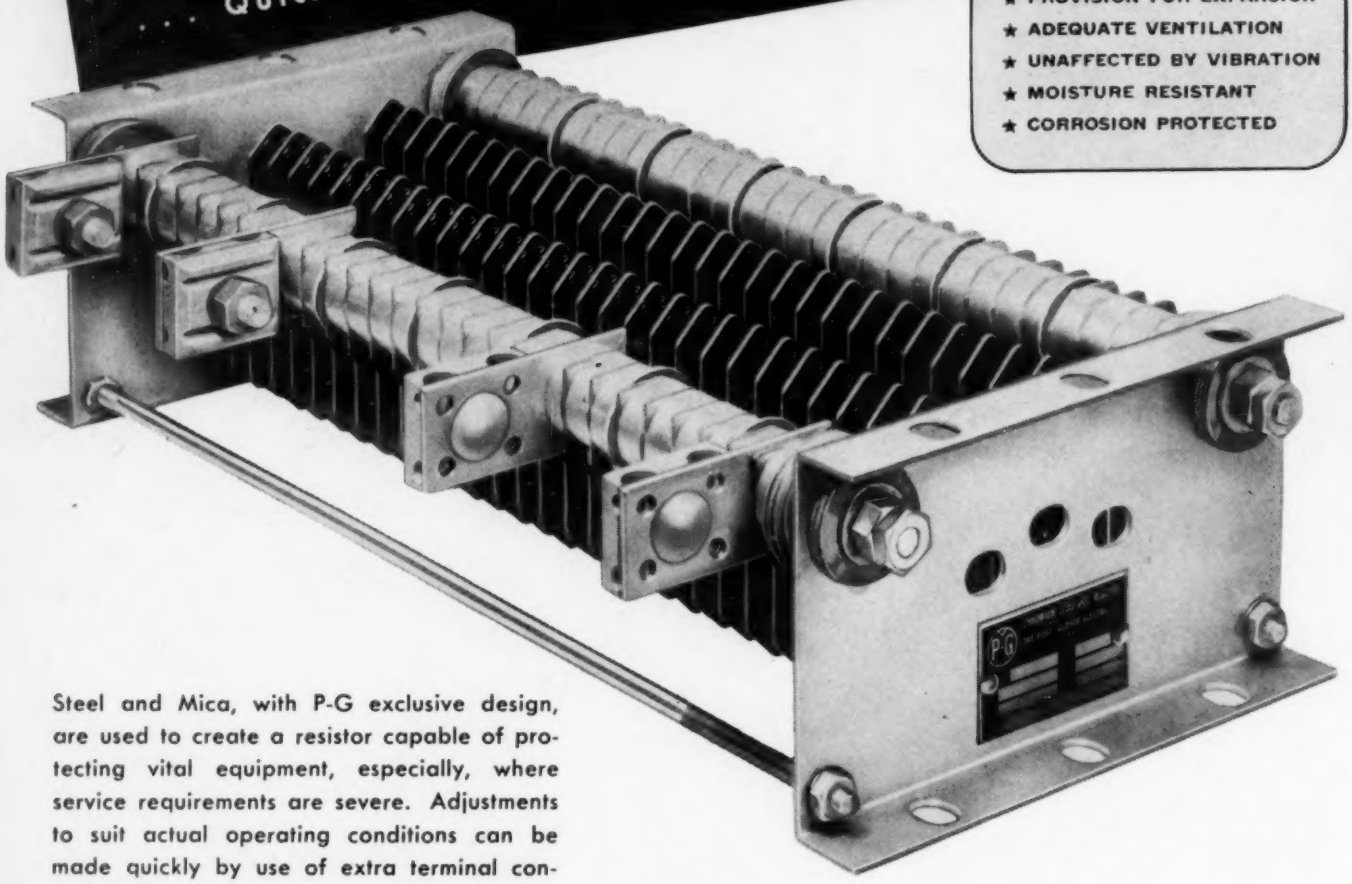
. . . Built for severe service conditions

. . . Protect vital electrical equipment

. . . Constant "Trouble Free" performance

. . . Quick adjustments easily made

★ ALL STEEL CONSTRUCTION
★ MICA INSULATION
★ RUGGED TERMINALS
★ PROVISION FOR EXPANSION
★ ADEQUATE VENTILATION
★ UNAFFECTED BY VIBRATION
★ MOISTURE RESISTANT
★ CORROSION PROTECTED



Steel and Mica, with P-G exclusive design, are used to create a resistor capable of protecting vital equipment, especially, where service requirements are severe. Adjustments to suit actual operating conditions can be made quickly by use of extra terminal connections usually available. Try P-G Resistors for constant "*Trouble Free*" performance.

BULLETIN No. 500 . . .
Gives detailed information . . . Copy on request.

P-G

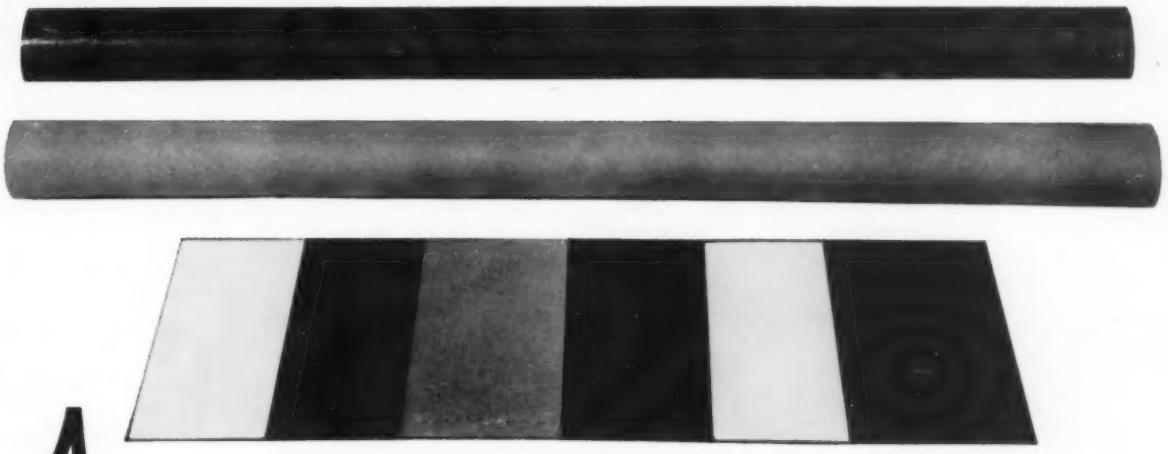
The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO

ELECTRO-TECHNICAL INSULATION



An assortment of **ELECTRO-TECHNICAL** Products.

Varnished Canvas • Varnished ***FIBERGLAS** Cloth and Tape • Varnished Cambric and Tape • Varnished Silk Cloth and Tape • Varnished Insulating Papers • Furnished in Rolls • Sheets and Die Cut Pieces.

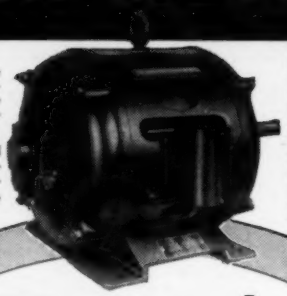
* T.M. Reg.—Owens Corning Fiberglas Corp.

ELECTRO-TECHNICAL PRODUCTS, INC.

ELECTRICAL INSULATION DIVISION

115 CENTRE STREET, NUTLEY 10, N.J.

Save time...Save money...Save worry...
LET A WAGNER MOTOR AUTHORITY HELP YOU
Select the RIGHT MOTOR for the job

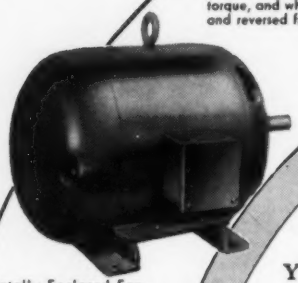


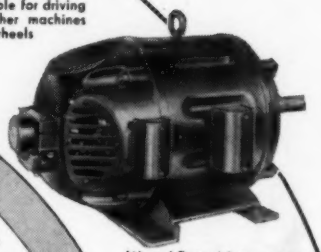
General-Purpose Squirrel-Cage Motors—low-slip, normal-torque motors suitable for a wide variety of applications.

Elevator Squirrel-Cage Motors—designed for elevators, cranes, hoists, and other applications involving very high starting-torque, and which must be started, stopped, and reversed frequently.

High-Torque Squirrel-Cage Motors—suitable for hard-to-start machinery such as crushers and compressors.

Punch-Press Squirrel-Cage Motors—a high-slip motor suitable for driving punch presses and other machines which have heavy flywheels or flywheel effect.





Wound-Rotor Motors—popularly known as "slip-ring" motors for applications involving variation in operating speeds and starting torques, or requiring very high starting-torque with low starting-current.

Totally-Enclosed Fan-cooled Motors—the ideal motors for locations where dust, filings, fumes, moisture, and other abrasive and corrosive agencies make the use of open-type motors undesirable. Approved for Class II Group G locations.

Multispeed Motors—for applications involving variation in motor speeds. Available as 2-speed, 3-speed, and 4-speed; constant-torque, constant-horsepower, and variable-torque motors.

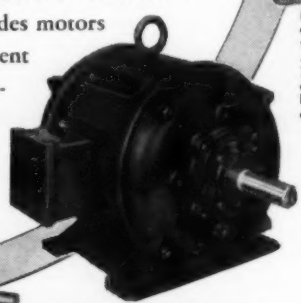
Explosion-Proof Motors—for Class I Group D locations involving flammable volatile liquids, highly-flammable gases, and other highly-flammable substances.

Wagner's
COMPLETE LINE MAKES POSSIBLE A WIDE SELECTION FROM STANDARD TYPES

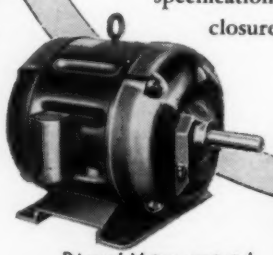
You'll save time, money, and worry if you consult a motor authority when you need electric motors.

To select the *right* type of motor for any given application, requires a comprehensive knowledge of motor ratings and characteristics, power transmission, control equipment, operating conditions, rules and regulations established by power companies, and even laws enacted by local governments. Our experts, motor specialists, make it their business to keep informed regarding all of these motor-application factors.

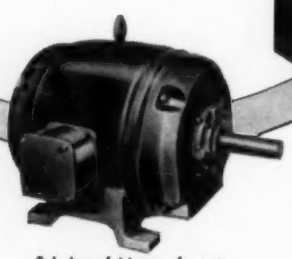
You'll save time and money if your motor needs can be filled by *standard* types. Wagner's ability to fit the RIGHT MOTOR to the job is due to a complete line which includes motors in sizes from 1/125 hp. to 400 hp., for all current specifications, with a wide variety of enclosure types and mountings.



Totally-Enclosed Nonventilated Motors—the equivalent of the totally-enclosed fan-cooled types, but in smaller ratings not needing external fan cooling.



Dripproof Motors—protected against dripping liquids and falling metal chips and other particles from entering the motors.



Splashproof Motors—for outdoor and indoor locations where motors are subjected to splashing liquids.

Write for
BULLETIN MU-182
which will give you a comprehensive story of the Wagner Line.

MOTORS are but one of several **WAGNER PRODUCTS** serving industry.

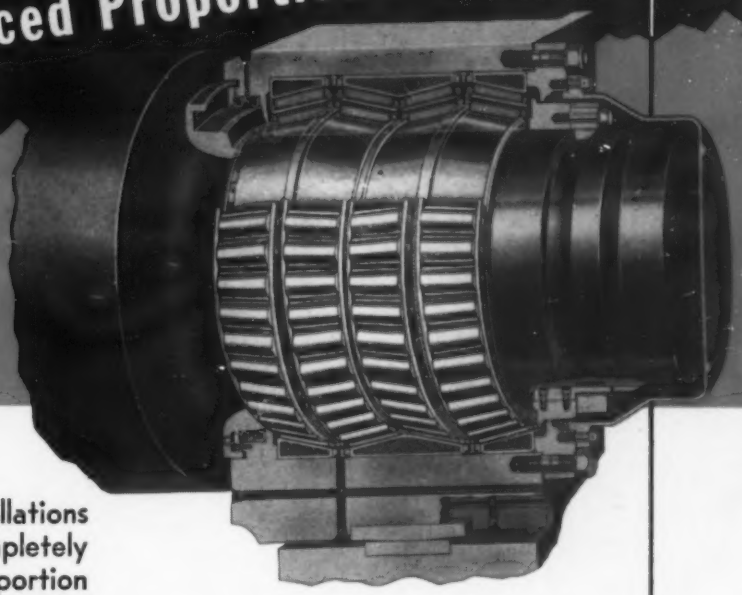
Other WAGNER PRODUCTS:
AIR BRAKES
•
BRAKE LINING
•
HYDRAULIC BRAKES
•
INDUSTRIAL BRAKES
•
INDUSTRIAL BRAKE CONTROLS
•
NoRoL
•
TACHOGRAPH (Recording Speedometer)
•
TRANSFORMERS

CONSULT OUR TRAINED FIELD ENGINEERS on your motor problems. There is one ready to serve you at the branch nearest you. Atlanta • Baltimore • Boston • Buffalo • Chicago • Cincinnati • Cleveland Dallas • Denver • Detroit • Houston • Indianapolis • Kansas City • Los Angeles • Memphis • Milwaukee Minneapolis • New York • Omaha • Philadelphia • Pittsburgh • Portland • St. Louis • Salt Lake City San Francisco • Seattle • Syracuse • Tulsa • Washington, D. C.

M45-15C

Wagner Electric Corporation
ESTABLISHED 1891
6483 Plymouth Avenue, St. Louis 14, Mo., U. S. A.
In Canada: Wagner Electric at Leaside, Ontario
ELECTRICAL AND AUTOMOTIVE PRODUCTS

Why more and more mill operators are swinging to Timken Balanced Proportion Bearings



Out of 18 rolling mill installations ordered so far this year, 14 are completely equipped with Timken Balanced Proportion Bearings on the back-up and work roll necks.

The big swing to Timken Balanced Proportion Bearings is on because:

1. Mill operators have always recognized the greater efficiency of anti-friction bearings on mill roll necks.

2. Now they can have the full advantages of anti-friction bearings on roll necks without making any sacrifices or compromises as regards other parts.

3. The design of the Timken Balanced Proportion Bearing assures maximum roll separating force capacity at mill speed with minimum roll neck stress and deflection.

4. Roll necks comparable in size with those made possible by sleeve type bearings can now be used with Timken Balanced Proportion Roll Neck Bearings.

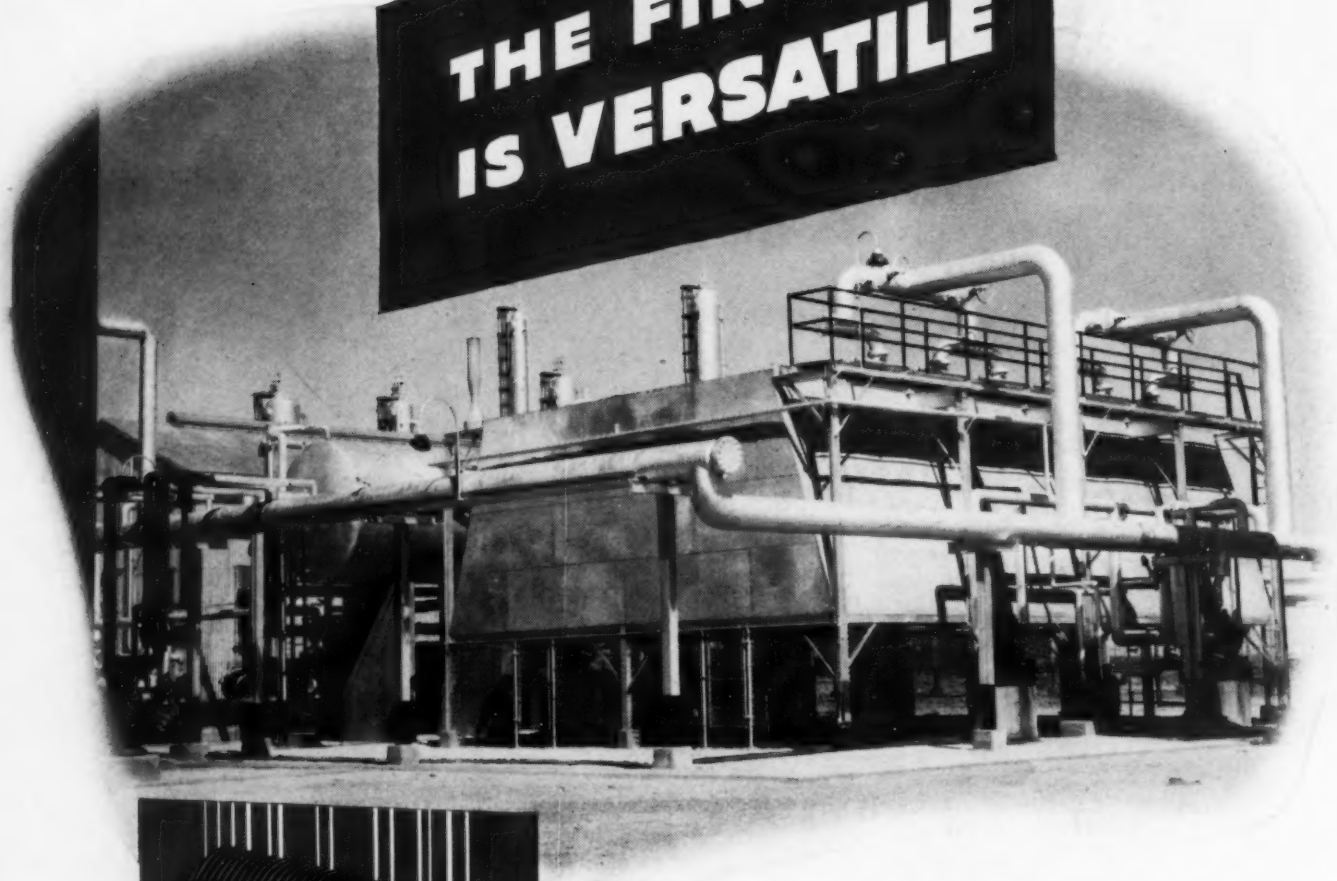
For speed, dependability, simplicity, endurance and economy, specify Timken Balanced Proportion Bearings. The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

ROLL NECK BEARINGS

THE FIN-FAN IS VERSATILE



FIN • FAN Cooling Units are produced and sold by: The Griscom-Russell Co., and The Fluor Corporation, Ltd.

Where liquids, gases, or vapors at temperatures as high as 1500° F and under pressures up to 5000 psi must be cooled, the FIN • FAN Cooler may be the answer. It is designed to give efficient operation with atmospheric air temperatures ranging from below 0° F to 140° F or higher. It can be placed in operation anywhere... on the ground or high in the air. No piping connections or pumps are required other than for the product being cooled. The FIN • FAN uses free air as the cooling medium.

FLUOR

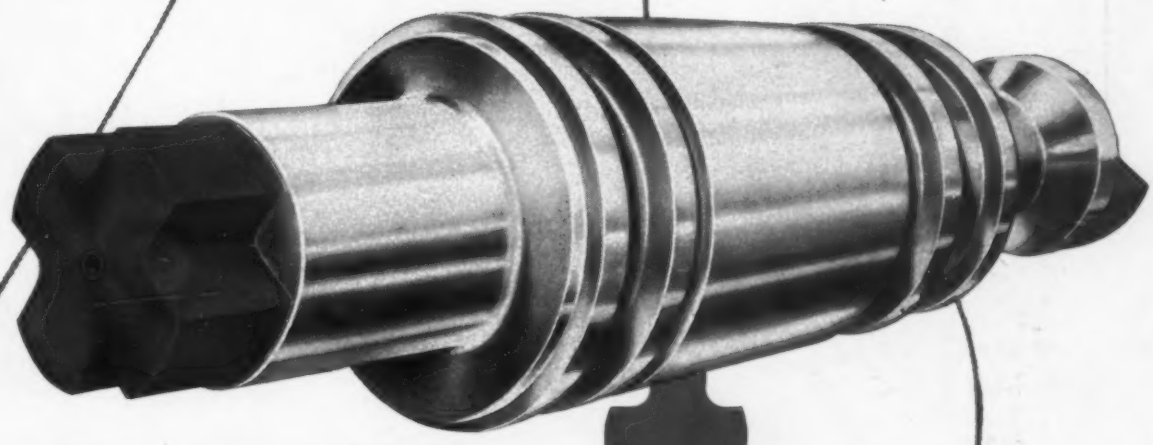
ALL SURE WITH FLUOR SINCE 1890

ENGINEERS • MANUFACTURERS • CONSTRUCTORS

PROCESS PLANTS AND EQUIPMENT FOR THE OIL, GAS AND ALLIED INDUSTRIES

THE FLUOR CORPORATION, LTD., 2500 S. Atlantic Blvd., LOS ANGELES 22 • New York, Pittsburgh, Kansas City, Houston, Tulsa, Boston

UNITED...
Originators of
Color Branded Rolls



*"UNITED SPECIAL" ALLOY STEEL
(Identified by Red Wabbler)

We believe this to be the most outstanding steel roll available to industry. Heat-treated to specific service requirements, its balanced alloy content assures maximum strength and extremely high wear-resistance. Eight distinct grades are available ranging in hardness from 30 to 55 Shore. Variations of physical properties to meet special conditions are controlled by carbon content, alloying composition and heat treatment. These rolls have an extremely wide application. UNITED engineers will gladly furnish you complete technical data, without obligation, of course.

**One of A Complete Line of 15 UNITED ROLLS Individually Color-Branded for Type Designation*

The 15 principal classifications comprising the UNITED ROLL LINE . . . each one a roll type successfully used in modern industry . . . are individually and distinctively *color-branded* to designate *grade*, *composition* and *service application*. Roll selection is thereby made easy and accurate.

UNITED ROLLS are the product of advanced metallurgical research and more than 40 years experience in roll design and manufacture.

UNITED ENGINEERING AND FOUNDRY COMPANY

Pittsburgh, Pennsylvania

Plants at PITTSBURGH · VANDERGRIFT · NEW CASTLE · YOUNGSTOWN · CANTON

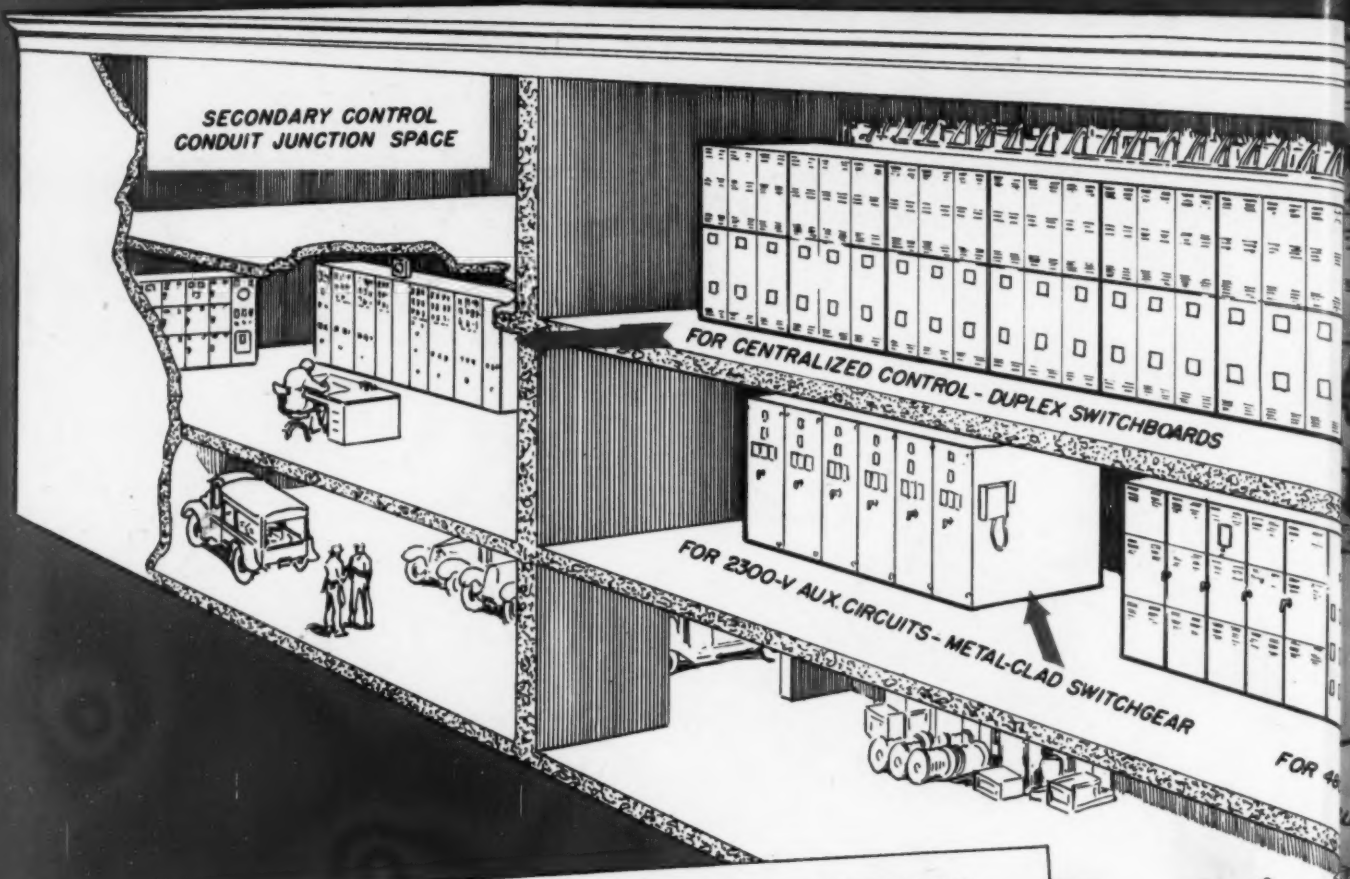
Subsidiary: Adamson United Company, Akron, Ohio

Affiliates: Davy and United Engineering Company, Ltd., Sheffield, England
Dominion Engineering Works, Ltd., Montreal, P. Q., Canada

**The World's Largest Designers and Makers of Rolls and Rolling Mill Equipment*

REG. U.S. PAT. OFF.

LOOK FORWARD TO THIS


SECONDARY CONTROL
CONDUIT JUNCTION SPACE
FOR CENTRALIZED CONTROL - DUPLEX SWITCHBOARDS
FOR 2300-V AUX. CIRCUITS - METAL-CLAD SWITCHGEAR

HOW ONE COMPANY MADE REAL SAVINGS IN PLANNING, INSTALLATION, and OPERATION — using *standard* units

THE sketch shows a recent installation of complete primary and secondary switchgear equipments. The entire installation, including duplex control board, metal-enclosed reactors, and bus runs, was planned as *one co-ordinated job.*

When another generator was required, instead of adding to its concrete-cubicle switchgear, this utility took advantage of modern equipment. This layout of metal-enclosed switchgear saved space. Bus runs were kept as short as possible.

Expensive, tedious construction-detail planning was avoided by utilizing standard repetitively built units. The installed cost was thousands of dollars lower than it would have been for on-the-job assembly or custom-tailored structures. Then, too, the cost was accurately predictable.

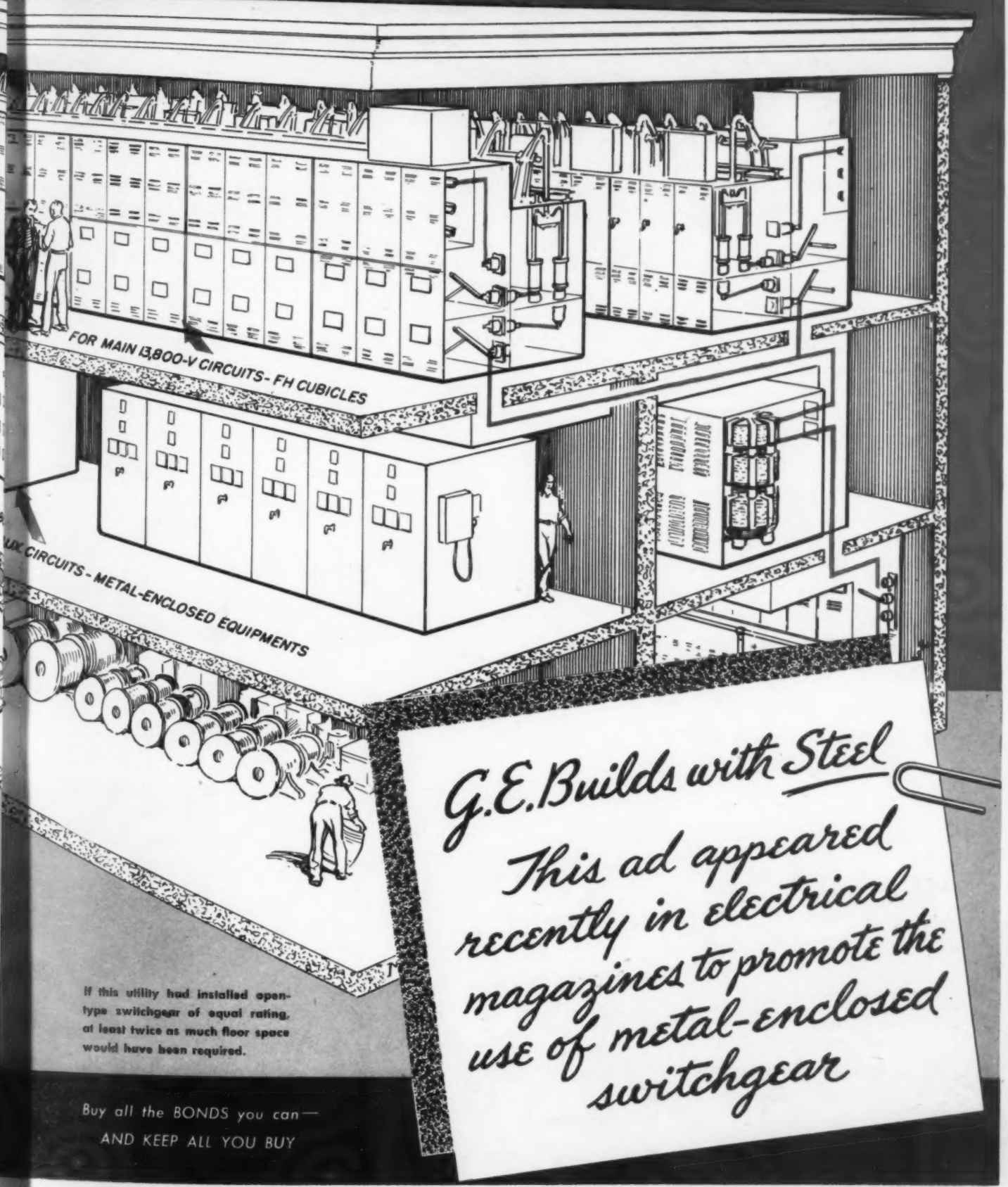
Note the short bus runs, and the central, air-conditioned control room which serves both the new and the old installations. Equipment like this represents the best modern practice of metal enclosure for safety to personnel and service.

The nearest G-E office will give you further information. *General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

855-19-7300

TYPE OF SWITCHGEAR



If this utility had installed open-type switchgear of equal rating, at least twice as much floor space would have been required.

G.E. Builds with Steel

This ad appeared recently in electrical magazines to promote the use of metal-enclosed switchgear

Buy all the BONDS you can—
AND KEEP ALL YOU BUY

GIANT BULLDOZERS pack the work of weeks into hours! Overnight they transform rough and rugged terrain into smooth, clean airfields and do many other Herculean tasks that are speeding the war's end.

MEN ARE MOVING MOUNTAINS!

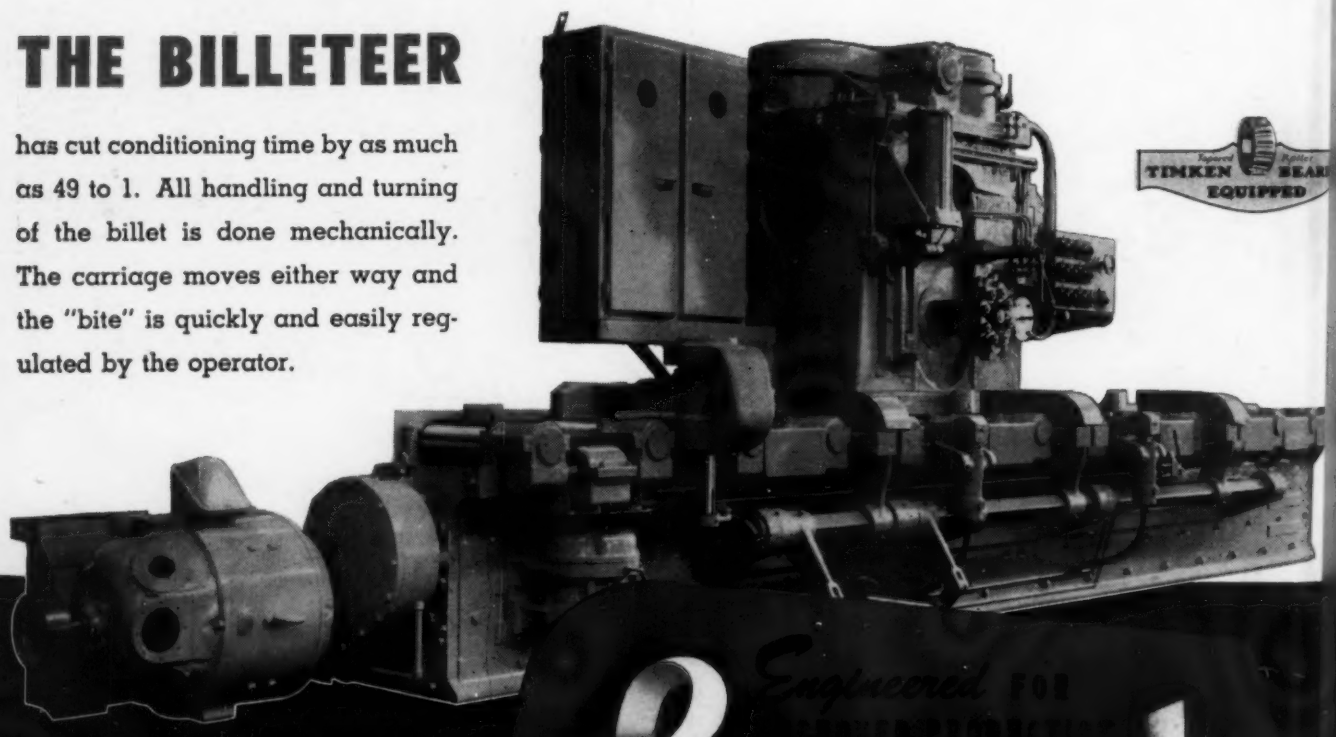
In the steel industry, the Bonnot Billeteer is accomplishing as great a feat in solving the man punishing and expensive operation of transforming rough and ragged billets into clean, smooth and useful materials.

Many mills are saving time and money with Billeteers, for each of these machines does the work of ten men or more — and does it better. Accurate, controlled chipping by the Billeteer saves many billets too full of flaws to make hand conditioning practical. It also saves tons of scrap often lost in other cleaning practice.

The Bonnot Billeteer is so easy to handle that an average workman can master the controls in a matter of days.

THE BILLETEER

has cut conditioning time by as much as 49 to 1. All handling and turning of the billet is done mechanically. The carriage moves either way and the "bite" is quickly and easily regulated by the operator.



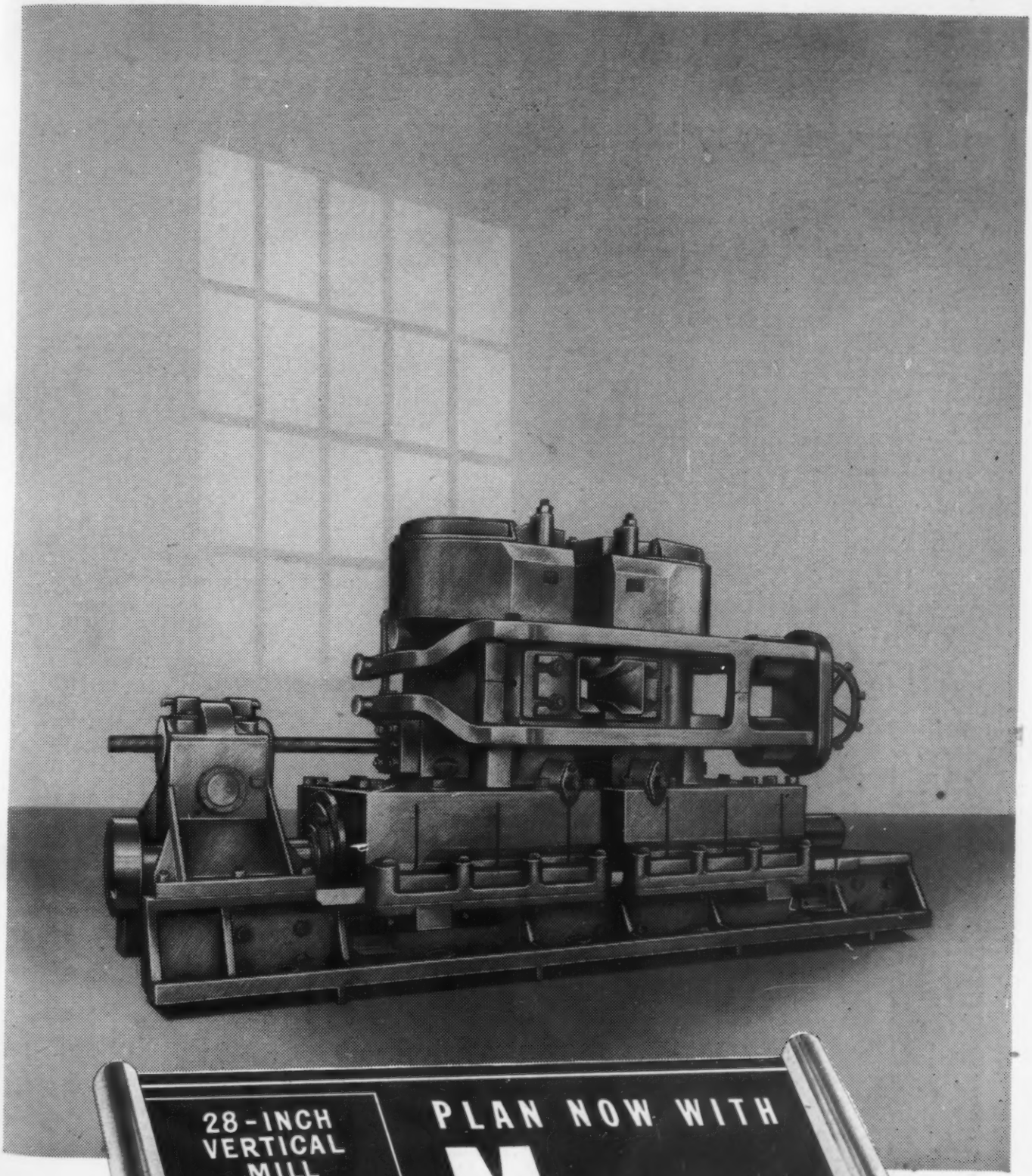
MECHANIZE YOUR BILLET CONDITIONING NOW. PREPARE FOR TOMORROW'S INTENSIFIED COMPETITION.

Engineered FOR

Bonnot

BUILDERS OF **THE BILLETEER**

ADDRESS CORRESPONDENCE TO



28-INCH VERTICAL MILL
MORGAN CONSTRUCTION CO.
WORCESTER, MASS.

PLAN NOW WITH

MORGAN

ENGINEERS AND BUILDERS OF ROLLING MILLS
WIRE MILLS • GAS PRODUCER MACHINES
REGENERATIVE FURNACE CONTROL

English Representative: International Construction Co., 56 Kingsway, London, W. C. 2, England

Airco Processes Help

Flame Scarfing with Airco heavy duty scarfing torches gives billets, slabs and blooms a quick conditioning prior to rolling.

MORE and more the steel industry is using Airco performance-proved oxyacetylene flame and electric arc methods for production speed, economy and flexibility. These versatile modern "tools" provide valuable aid in many ways—by speedily cutting up scrap and ladle skulls for charging, cropping ingot hot tops and bottoms, oxygen lancing, flame cutting and electric welding for maintenance and new construction.

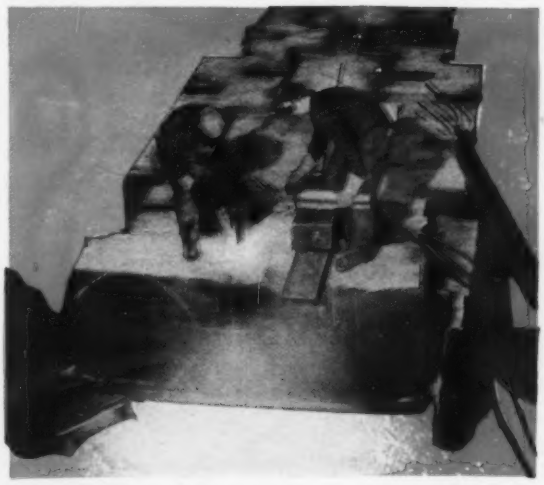
The illustrations on these pages show just a few of the many Airco processes widely used by the steel industry. For helpful technical information in applying these processes to your particular problem—write Airco's Applied Engineering Department. Address your nearest Air Reduction office, or Dept. IS in New York.

AIRCO

Speed Steel Production

Electric Arc Welding quickly fabricates a buck stay for an open-hearth furnace to replace a burned-out stay.

Flame Cutting by hand saves valuable time on many jobs. It is widely used by industry to quickly trim plate to size; for making replacement parts, dismantling and many other production, maintenance and salvage jobs.



Machine Gas Cutting opens the way to important savings of production time and cost when cutting heavy slabs, ingots and many other large, thick sections. The Airco Heavy Duty Radiagraph shown here is especially designed for flame cutting very heavy sections (20" to more than 40") from carbon and alloy steels.

Oxyacetylene Welding speedily repairs an open-hearth furnace door frame, worn thin in normal service. Weak spots are strengthened by patches welded into place with the hand torch.

Braze Welding (building up with bronze metal) restores innumerable worn or damaged parts to service quickly—with minimum interruption to production. An effective method of making repairs—often without dismantling equipment.

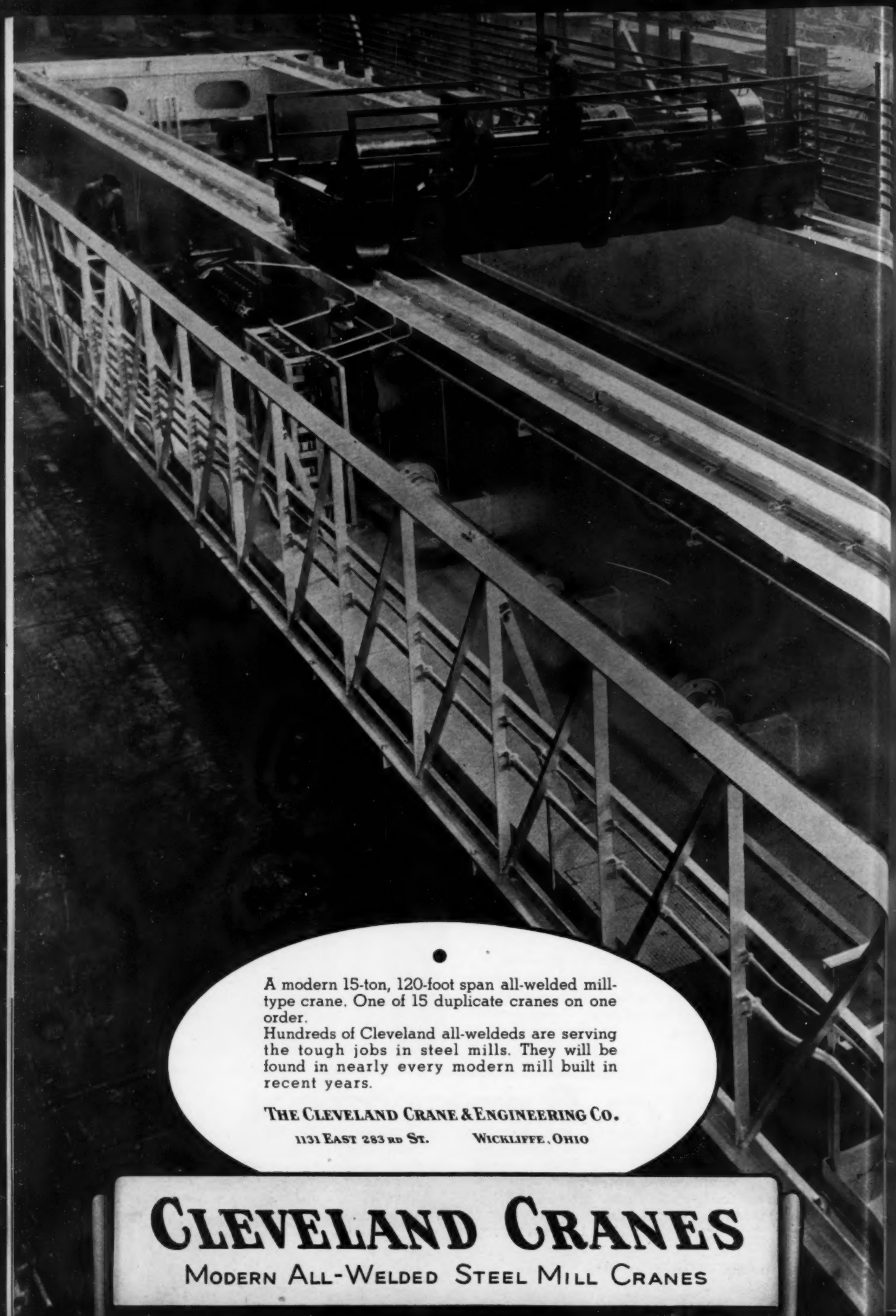
AIR REDUCTION

General Offices: 60 E. 42nd STREET, NEW YORK 17, N.Y.

In Texas: MAGNOLIA AIRCO GAS PRODUCTS CO. • General Offices: HOUSTON 1, TEXAS

Offices in all Principal Cities

Represented Internationally by Airco Export Corporation



A modern 15-ton, 120-foot span all-welded mill-type crane. One of 15 duplicate cranes on one order.
Hundreds of Cleveland all-weldeds are serving the tough jobs in steel mills. They will be found in nearly every modern mill built in recent years.

THE CLEVELAND CRANE & ENGINEERING CO.

1131 EAST 283 RD ST. WICKLIFFE, OHIO

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

Crops *and* Shorts

NO steel plant installation of equal magnitude and complication ever crystallized into efficient, workable form with such rapidity as did our wide continuous strip mill plants. We believe no one will contradict the statement that this was because of the free interchange of information on the subject. Now, in spite of this example of the benefits of cooperation, we find some cases of the old "hush-hush" on the subject of electrolytic tinning. In view of the results attained thus far in this process, might not a little more free speaking on the subject be a good thing?

▲

A NEW survey indicates that the coming fuel year's requirements for hard and soft coal will exceed expected production by about 37,000,000 tons. At the same time, the nation's stockpile of bituminous coal has dropped to its lowest level since 1941. This estimate takes into account the defeat of Germany, but may be quickly changed as conditions are affected by the war with Japan and the problems of industrial reconversion.

▲

THE field staff of F. W. Dodge Corporation reports spotting 99,638 specific construction projects, totaling $15,746,202,000 in value, for postwar execution in the 37 states east of the Rocky Mountains.

▲

ONE of the newsletters says that the meat situation will be relieved somewhat by late autumn through policies to be applied by the new War Food Administrator. We never ate a policy, but still think we would prefer relief through steaks applied by a fork.

▲

IN discussing the problem of surplus machine tools before an A. S. M. E. meeting, A. G. Bryant, president of Bryant Machinery and Engineering Company, recommended that the government set aside as a strategic military reserve at least 50 per cent of the general purpose machine tools and production equipment owned by the government, establish a single surplus property administrator with full authority to fearlessly develop cooperative arrangements with industry for utilization of remaining surpluses, and simplify the Surplus Property Act by eliminating futile restrictions which create confusion and cause delay.

▲

A POSTWAR worry for many people is the necessity of going back to getting what they are worth, but we'll bet the G-Is are not afflicted with it.

▲

IN a message to employees of the Link-Belt Company, president William C. Carter says, "Remember, always, that it is the buyer of our products — the customer — and he alone, who makes our jobs and keeps them going; but he isn't 'crazy in the head' and he won't pay us more for what he wants if he can get the same value for less money from our competitor." That's a thought worth remembering and one which many individuals and companies will have to relearn.

▲

IT is a characteristic of the American people to idolize its heroes. It is likewise an American characteristic to condemn its idols for qualities which, in a lesser man, might be called human nature. General George S. Patton has reaped criticism for cuffing a soldier suspected of "gold bricking," for profanation of the name of God in a speech emphasizing the bloodiness of the European fighting, for referring to his men as fools, and for telling youngsters that they were the soldiers and nurses of the next war. The man who does things always reaps criticism, but isn't it about time that we stop insisting that a fine soldier must also be the quintessence of oratory, diplomacy, omniscience, infallibility, etc.?

▲

SOME verse on a mural in the Pick-Ohio Hotel in Youngstown, Ohio, attributed to Lt. J. T. Langland, U. S. A., states:

"I thought a cow could never tend
A furnace — Fact, I knewed it;
But will earth's wonders never end!
She couldn't, but she 'dood' it."

▲

AMIDST all the clamor against bureaucracy in government, perhaps some of our large corporations, some of which are as badly bound up in red tape, might profit by a little introspection.

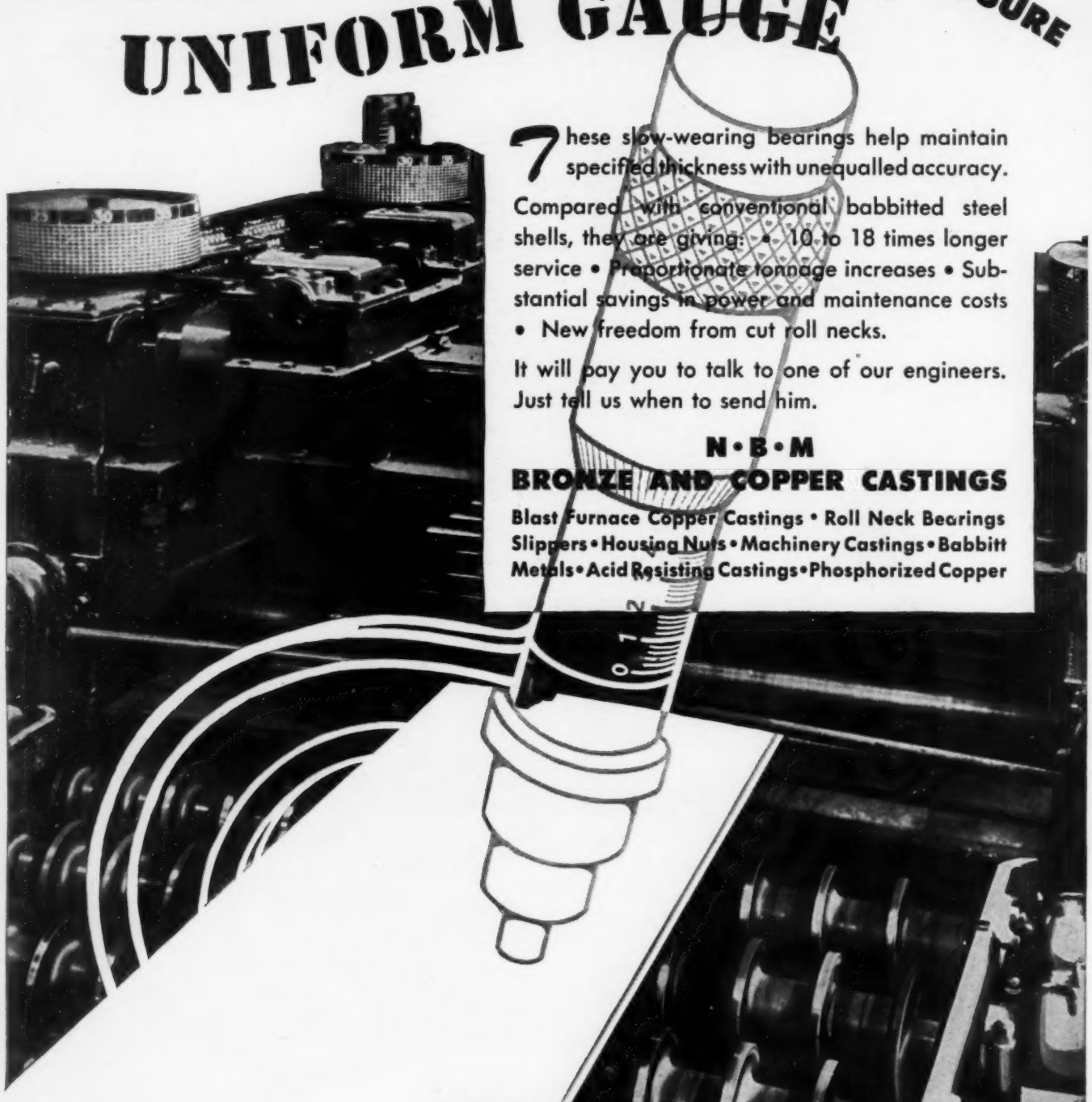
▲

HAT manufacturers, who have long worried about the bare-headed trend, might strengthen their stand by working toward the reduction of the hat-checking racket. Remember the newspaper columnist who, after accurate accounting, reported that his expense was $8 for a hat, $1 for cleaning and $338.35 for checking?

▲

HOUSE Bill 2624 and Senate Bill 752 provide for government stock-piling of certain metals and other materials of a critical nature, in order to guard against future emergency shortages such as those encountered at the start of the present war. It would also seem that this might mean some return on our lend-lease outgo. If you like it, write your senators and congressmen.

N•B•M #200 BRONZE PLATE MILL BEARINGS ASSURE UNIFORM GAUGE



These slow-wearing bearings help maintain specified thickness with unequalled accuracy.

Compared with conventional babbitted steel shells, they are giving: • 10 to 18 times longer service • Proportionate tonnage increases • Substantial savings in power and maintenance costs • New freedom from cut roll necks.

It will pay you to talk to one of our engineers. Just tell us when to send him.

N•B•M

BRONZE AND COPPER CASTINGS

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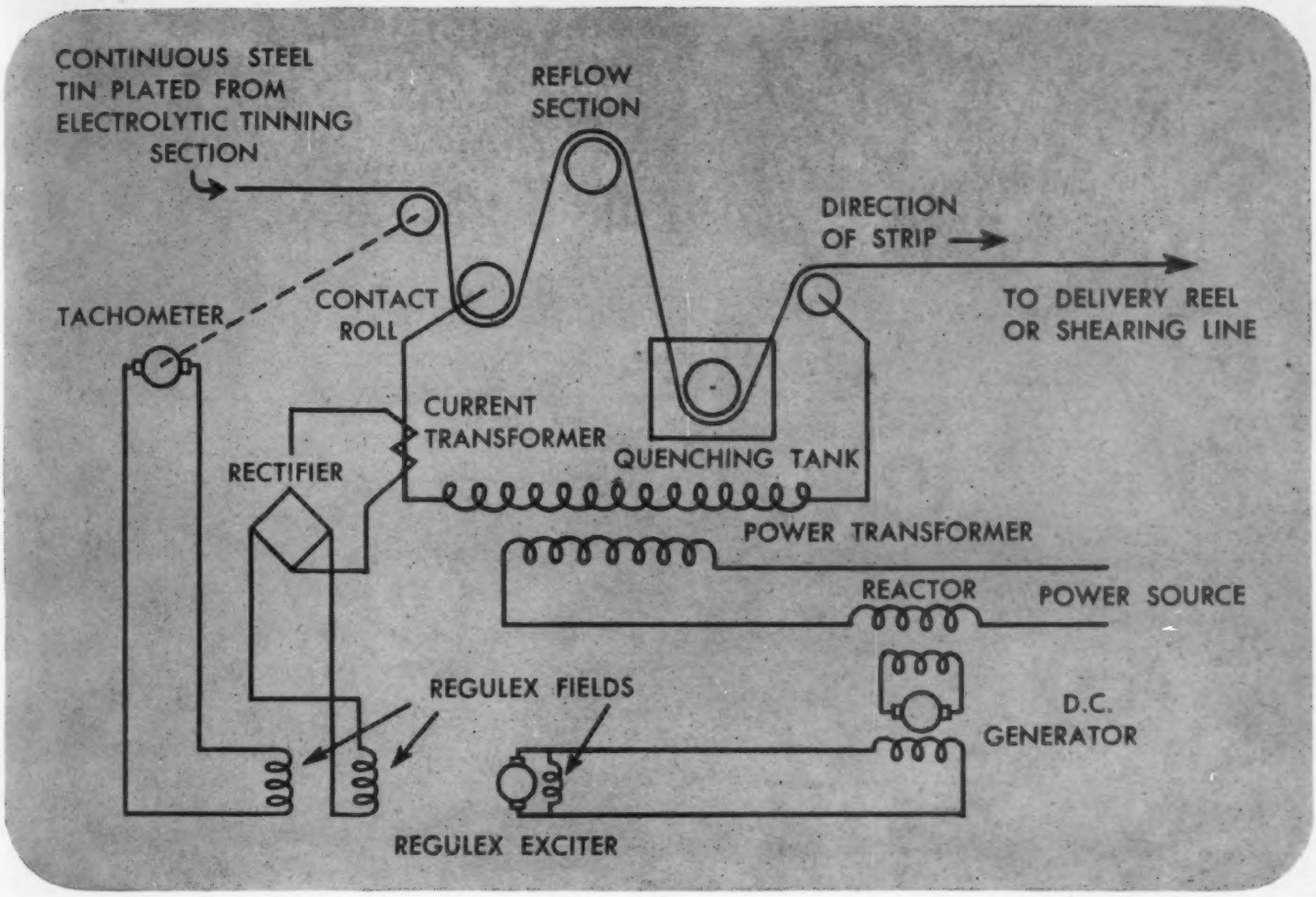

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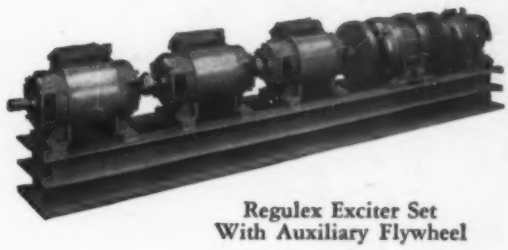

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- Auxiliary generator makes Regulex control self-sustaining and independent of a direct current shop source, if desired.

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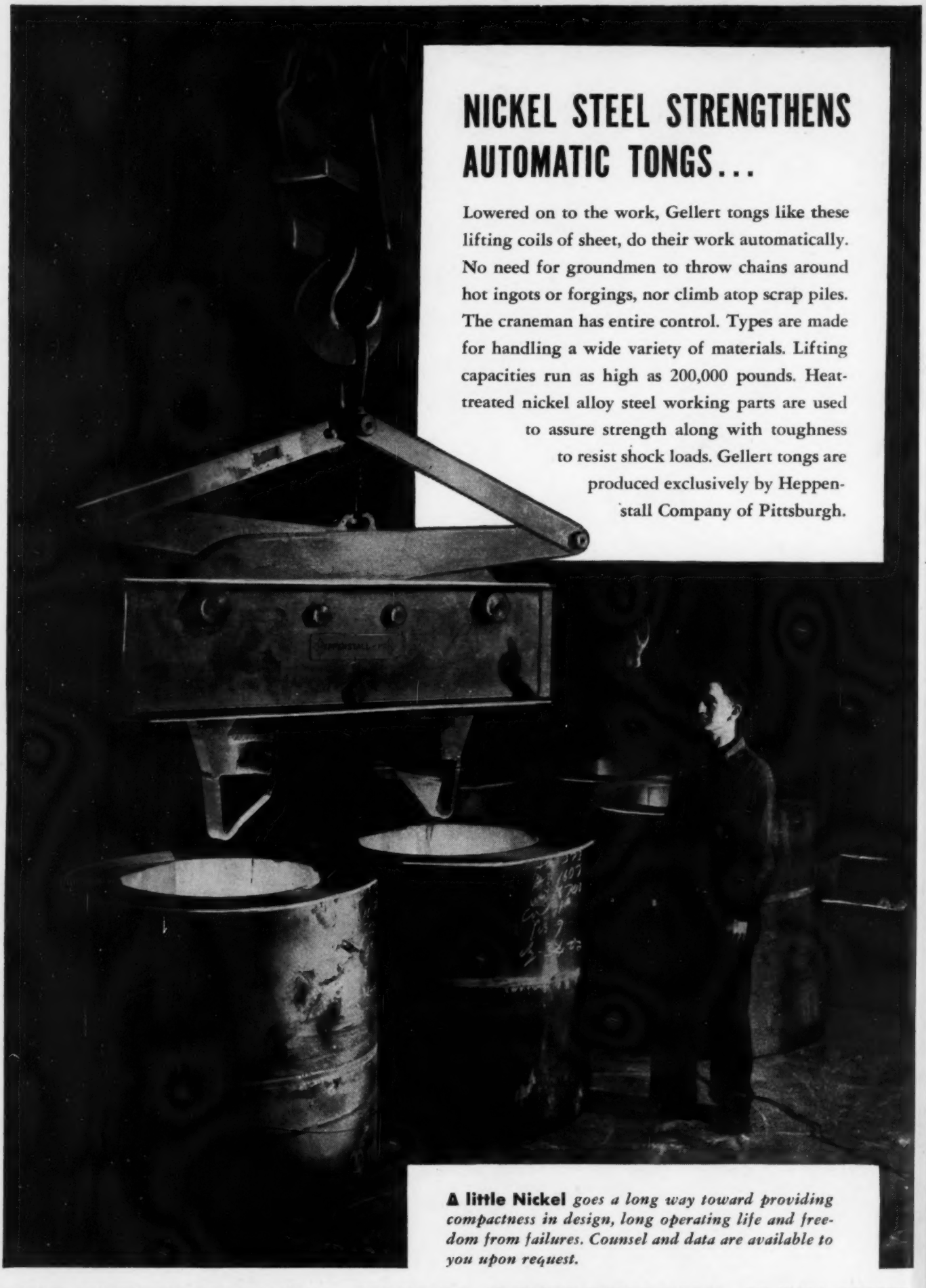

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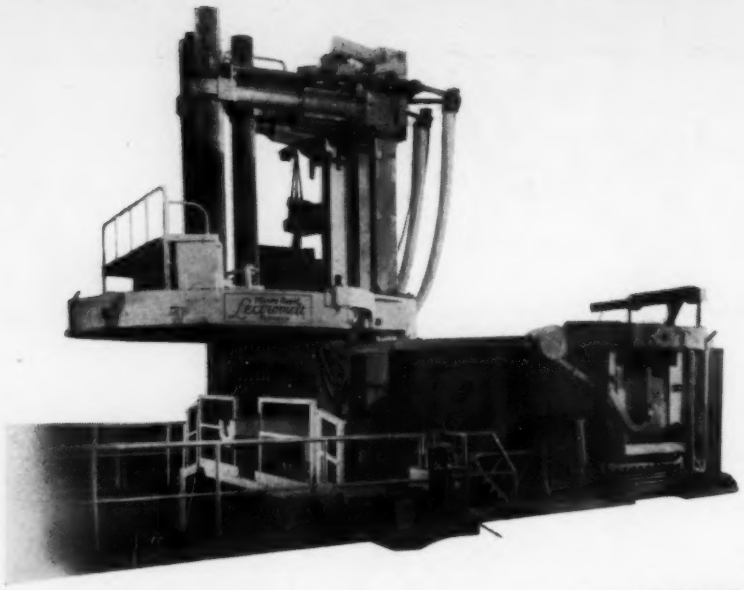

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Process Control IN THE PRODUCTION OF Sulphur Steel

. . . . an insight into the benefits derived from a controlled process of manufacture in producing semi-finished billets of low carbon free-cutting steels in the open hearth . . . . the relative importance of open hearth, soaking pit, and blooming mill practice is discussed . . . .

by G. A. Ferris and H. Clark

PROCESS CONTROL ENGINEERS

FORD MOTOR COMPANY

DEARBORN, MICHIGAN

▲ INCREASED demands for the production of free cutting steels, especially those within the lower carbon ranges, have enhanced the endeavors of open hearth operators to develop a practice which will overcome to the greatest possible extent the hot-short condition prevalent in these types of steel. Because of the fact that production difficulties encountered are mainly of a surface nature and especially troublesome in the lower carbon ranges, this discussion, although applicable in many cases to all types of steel, is based specifically on the production of SAE X-1314 and SAE 1117 steel and on factors influencing their surface condition.

The adding of sulphur to steel as an aid to machinability has long been practiced; however, the form and disbursement of the sulphur in the steel, due to its affect on surface quality, is a matter of utmost importance, especially at the present time with war requirements demanding large amounts of steel that must be machined in large tonnages. Thus, the open hearth melter is faced with the problem of producing the greatest possible quantities of a first class product that can be machined in a minimum of time.

In an effort to make this paper somewhat concise and to the point, every detail of operation has not been included. Only the points of operation seeming to exercise the greatest importance on the final results will be discussed. This study is based on a conventional basic open hearth practice with an approximate 50-50 metal and scrap charge, and covers a production of 30,000 tons of steel. Operating variables shall be discussed in their regular order of production and graphs will be introduced with these variables plotted against the actual percentage of rejections resulting from surface defects in the semifinished billet.

Presented before A. I. S. E. Detroit District Section Meeting, January 9, 1945

RAW MATERIALS AND CHARGING

Due to the adverse affect of contaminated scrap, the importance attached to the selection of scrap before charging can not be too strongly stressed. Average run-of-mine scrap is not acceptable. Only scrap of predetermined analysis, preferably known backscrap, will give the desired results. The affects of contaminated scrap are well illustrated in Figures 1, 2 and 3. A surprising result of this investigation, as shown in Figure 1, is the apparent ill effect of a high residual sulphur content of the bath before the final ladle addition of sulphur is made. Best results are obtained with a residual sulphur content of .025 per cent or less. This would tend to discourage extensive charging of sulphur backscrap in sulphur steel. To further emphasize the importance of selecting a clean grade of scrap for charging, Figure 2 illustrates the total undesired residuals and

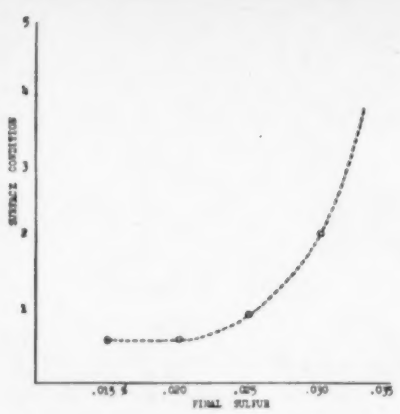


Figure 1 — Surface condition vs residual sulphur analysis.

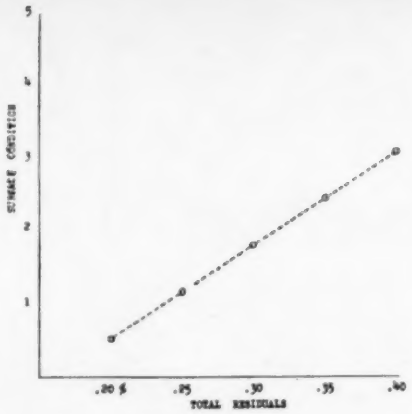


Figure 2 — Surface condition vs total residuals.

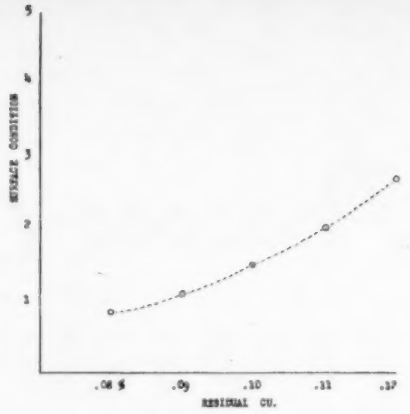


Figure 3 — Surface condition vs residual copper.

their resulting effects on surface condition. In this particular graph the combined total amounts of chromium, nickel, molybdenum, copper and tin were considered. The importance of keeping this total under .30 per cent can readily be seen. Probably the most harmful element of this group is copper, as shown in Figure 3. Copper in excess of .10 per cent in combination with sulphur is definitely harmful. Chemical determinations as early as possible after meltdown, with the alternative of diverting to another type when necessary, is the best protection against these undesired residuals.

A well balanced charge of heavy and light scrap with controlled meltdown carbons is of primary importance. In computing charges for accurate meltdowns, the analysis as well as the physical characteristics of all the scrap and iron to be used must be taken into consideration to decide the amounts of each to be charged. For convenience in figuring the heat, the elements concerned are converted to a common denominator. With the value of carbon as one, the other elements are valued according to their combining weight with oxygen. In this manner, the desired amount of carbon equivalent may be determined by comparison with heats previously made. The amount of limestone to be charged is calculated by computing the total silicon contained in the charge and charging sufficient limestone to give a proportion of approximately one part of silica to each 3.5 parts of calcium oxide. Any corrections to the lime-silica ratio resulting from irregularities in the silicon analysis of the hot iron should be made immediately following the hot iron addition. Figure 4 indicates the desired oxide additions at meltdown for 180 ton heats. A medium meltdown requiring a moderate oxide addition produces the best results. It is essential that sufficient carbon exist to allow ample time for working the slag.

Soft melts must be avoided. Although a hot iron addition is not detrimental if a good boil is permitted after the addition, the resulting affect on temperature would prohibit this practice on types where temperature plays such an important role.

WORKING AND FINISHING

The form and speed of the oxide additions to the bath after lime-up exercise considerable importance on the final outcome. Figure 5 indicates the desired rate of carbon drop which is approximately .20 per cent per hour. To avoid adding an excessive amount of iron ore

Figure 4 — Surface condition vs oxide addition at melt-down.

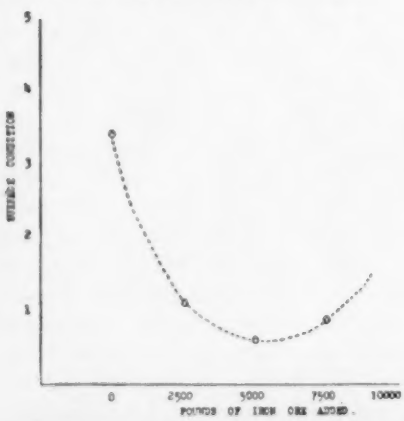


Figure 5 — Surface condition vs rate of carbon drop.

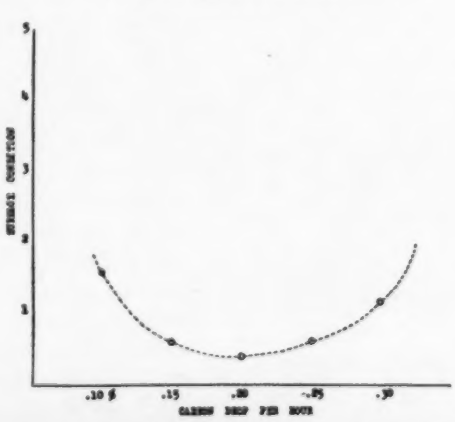
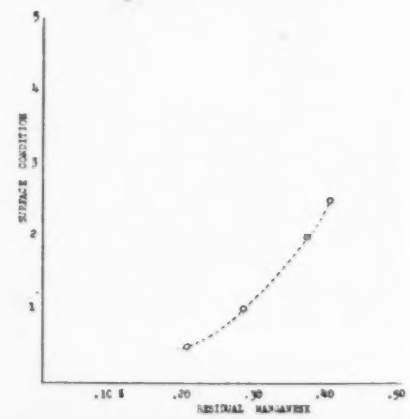


Figure 6 — Surface condition vs residual manganese.



with its contained siliceous impurities, an addition of mill scale and raw dolomite to the slag with a small addition of lump iron ore to promote the action, will insure a rapid carbon elimination. This addition aids in shaping up the slag, as well as hastening the degree of oxidation to the end point.

In considering desirable conditions at the end point of the heat, before blocking, it is essential that it be recognized that these conditions can only be the result of carefully controlled operations during the earlier stages of the heat. With this thought in mind, an examination of Figure 6 indicates the effect of final residual manganese on the surface condition. The manganese content of the iron charged will slightly affect this figure; however, considering the normal run of basic pig iron with a manganese content between 1.50 and 2.00 per cent, the advantages of a medium low residual manganese of approximately .20 per cent can very readily be seen. Considering that this figure is indicative of the bath temperature and the state of oxidation and slag bascity, the importance of controlled operations to arrive at desirable residual manganese is a necessity.

The best indicator an operator has of the condition of the slag is the FeO content. Figure 7 shows the slag FeO consistent with good surface quality. This again is a relative figure depending upon proper charging and melting practice. A slag iron oxide of 15-20 per cent insures a slag capable of retaining the phosphorus.

The importance of blocking the heat as high as possible in carbon to avoid extensive recarburization is defined in Figure 8. Best practice appears to result from maximum final preliminary carbons and the corresponding use of low carbon manganese additions. Considering these particular types of steel, a preliminary carbon of .18-.20 per cent will give the most satisfactory results.

In any discussion of sulphur steel, the amount of final manganese is a controlling factor in respect to surface quality. Figure 9 clearly illustrates the final manganese range within which good surface quality may be expected. Due to the importance of the formation of a manganese sulphide rather than an iron sulphide, the manner in which the manganese and sulphur is added exercises considerable influence on the final outcome. Best results as indicated in Figure 10 are

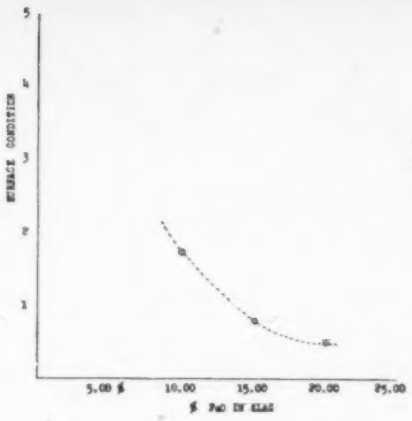


Figure 7 — Surface condition vs iron oxide in slag.

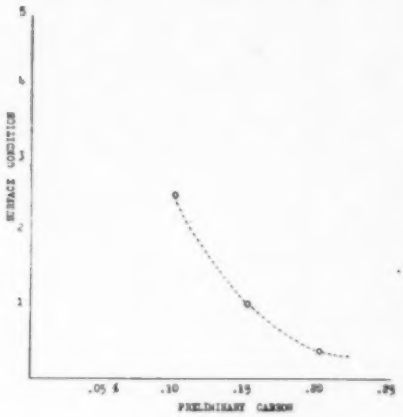


Figure 8 — Surface condition vs final preliminary carbon.

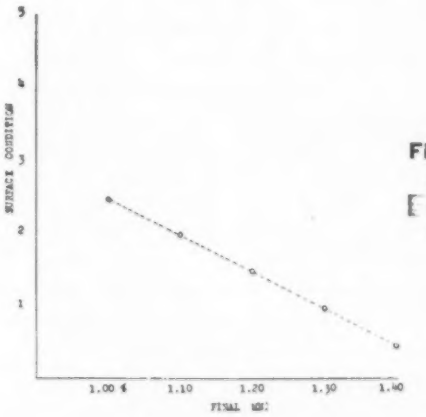


Figure 9 — Surface condition vs final manganese content.

Figure 10 — Surface condition vs per cent of manganese added to ladle.

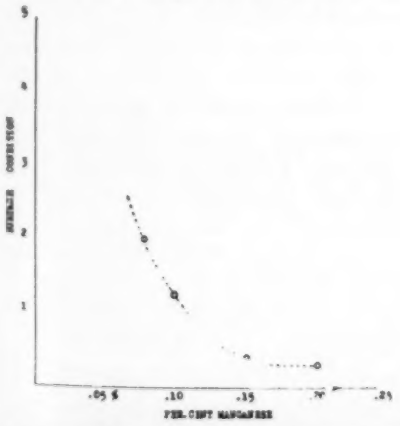


Figure 11 — Curve showing effect of iron oxide in slag on manganese recovery.

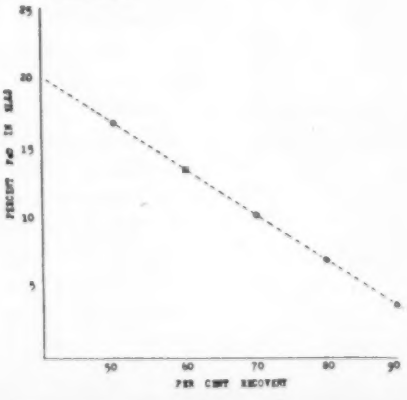
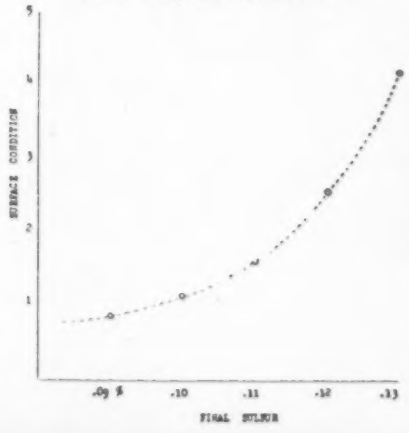


Figure 12 — Surface condition vs final sulphur content.



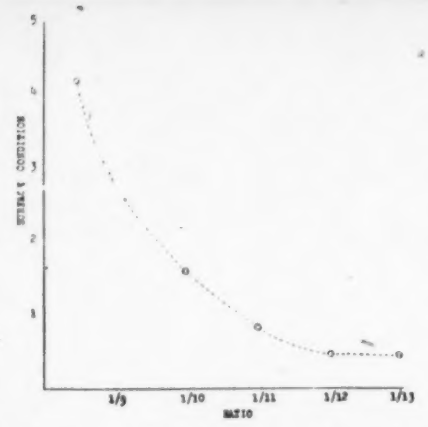


Figure 13 — Surface condition vs ratio of final manganese to final sulphur.

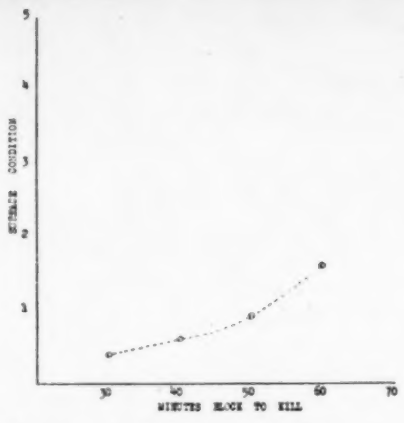


Figure 14 — Surface condition vs time between blocking and tapping.

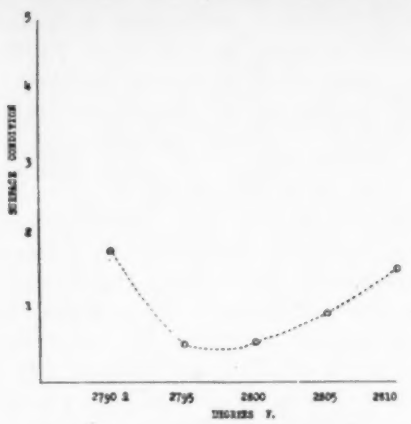


Figure 15 — Surface condition vs teeming temperature.

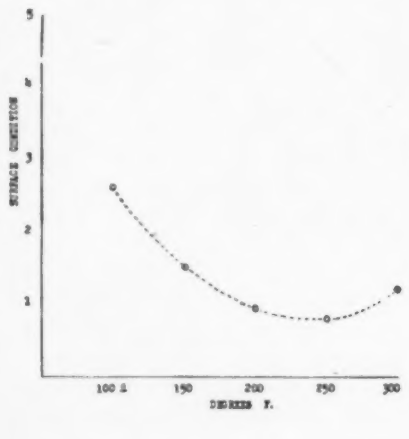


Figure 16 — Surface condition vs mold temperature.

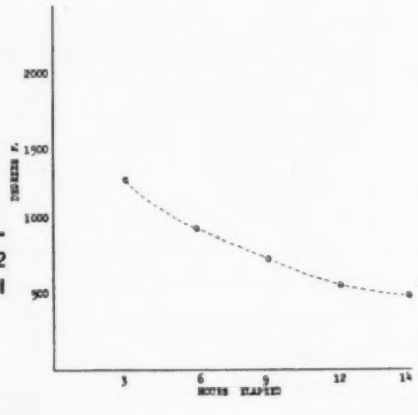


Figure 17 — Temperature drop of 22 in. ingot while still in mold.

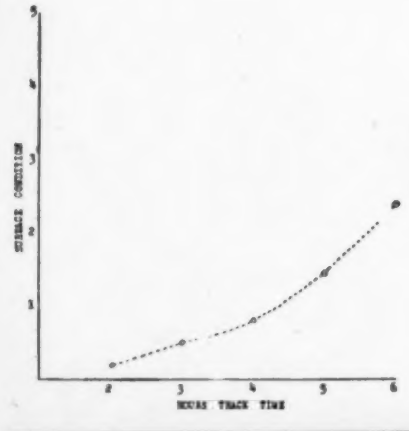


Figure 18 — Surface condition vs track time.

obtained when 15-20 per cent of the total manganese required is added to the ladle with the sulphur.

A standard practice in blocking heats with predetermined manganese recovery charts based on slag FeO will insure a final manganese within the desired range. Figure 11 illustrates a very satisfactory practice for the types of steel considered in this discussion. Considering a 1.00-1.30 per cent manganese specification, the heat is blocked with 15 per cent silico-manganese to the extent of a 1.00 per cent manganese addition. Considering a slag FeO of 10 per cent, the manganese recovery from the bath addition would amount to about .70 per cent. This, in addition to an approximate .25 per cent residual manganese, would allow for a .30 per cent ladle addition of manganese, going to the high side of the specification. In compiling this graph the entire manganese loss is calculated from the bath addition; thus approximately 100 per cent recovery can be expected from the ladle addition.

In regards to the final sulphur analysis, it is sufficient to say that the lower the better, as long as it is within the specifications. Figure 12 readily confirms this. The importance of a final low sulphur and high manganese are further emphasized when a study is made of Figure 13, indicating the ratio of sulphur to manganese consistent with good surface quality. To expect minimum breakage at the blooming mill, this ratio must be at least 1 to 12.

The ultimate value of keeping the time interval from block to tap at a reasonable minimum was continually brought to our attention in this study. Time after time comparatively well handled heats containing an abnormal percentage of surface rejections were directly traceable to delays occurring between blocking and tapping. Assuming that the FeO content of the bath reaches a minimum in 20 to 30 minutes after the silico-manganese addition, it is obvious that the heat should be tapped before the reoxidation of the FeO from the slag to the metal occurs. Figure 14 shows the trend in the surface quality with increasing time intervals between blocking and tapping.

The teeming temperature of the metal probably has a more pronounced affect on the final outcome than any other single variable. Since calculated temperatures of

molten metal are fraught with so many difficulties, comparable temperature observations with carefully standardized instruments are the only basis for results. The relationship between temperature and surface quality are presented in Figure 15. The only safe method in arriving at this temperature lies in tapping the steel at temperatures uniformly high enough to allow for usual operating delays and in holding the heats for a calculated interval in the ladle. The important part of temperature insofar as surface quality is concerned is to pour the heat sufficiently hot enough to eliminate scabs and low enough to avoid cracks; 2790 F represents the best compromise temperature, according to our readings taken of the metal coming from the pouring dish, using the optical pyrometer.

MECHANICAL HANDLING

Certain precautions in regard to mold handling must be considered in discussing surface quality. It is not the intention of this paper to discuss the advantages or disadvantages of various mold washes. With proper application, mold washes have proven beneficial. However the apparent all-important factor lies in having the molds at the proper temperature before teeming. As shown in Figure 16, this temperature is between 200 F and 300 F. Rotating the molds so that there is sufficient time between heats for cooling and preheating was found to pay large dividends.

The handling of the ingots between completion of teeming and reduction in the mill is a matter requiring careful attention as to times and temperatures. Since the type of ingots considered is delivered to the soaking pits in molds, charging with a minimum temperature loss is possible. In Figure 17 the surface temperature loss of a 3.5 ton ingot while still in the mold is shown. It can readily be seen that after a three-hour interval this steel is below its critical temperature and thus susceptible to cracking as a result of cooling strains set up. In every case fast delivery to the soaking pits has proven that better surface and less conditioning will result. The importance of low track time is well indicated in Figure 18.

SOAKING PIT PRACTICE

The practice of equalizing soaking pit and ingot temperature before charging must be strictly adhered to. Ingots below their critical temperature should never be charged into hot pits. Skin ruptures occurring during a rapid cooling will also occur when too drastic a change in temperature takes place. In Figure 19 a ratio value of ingot temperature to pit temperature was established and plotted against surface quality. It very clearly indicates that the nearer the ratio value is to unity, the more favorable will be the final results. The delay caused by cooling the pits before charging cold ingots is by far compensated for by better surface and less conditioning costs, especially on tender steels.

Due to the importance of soaking pit practice, too much care cannot be exercised in this operation. Generally speaking, the time required to heat the ingots

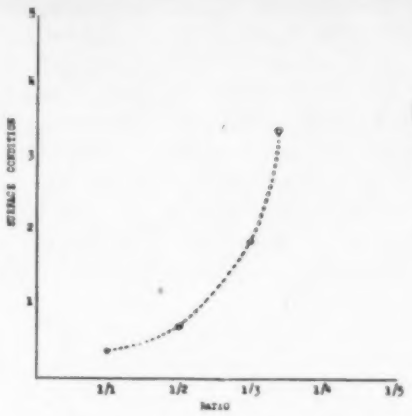


Figure 19 — Surface condition vs ratio of ingot temperature to pit temperature at charge.

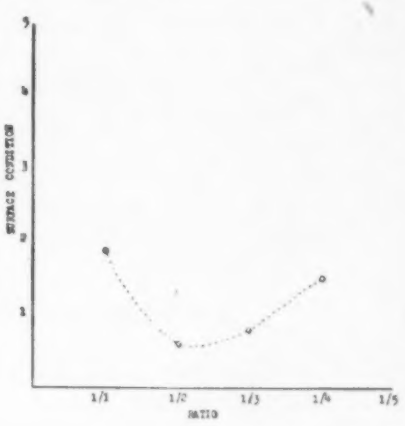


Figure 20 — Surface condition vs ratio of track time to pit time.

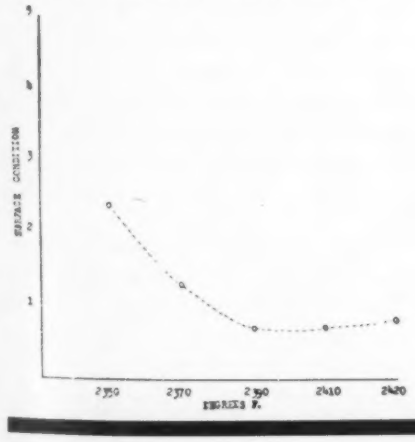


Figure 21 — Surface condition vs final soaking pit temperature.

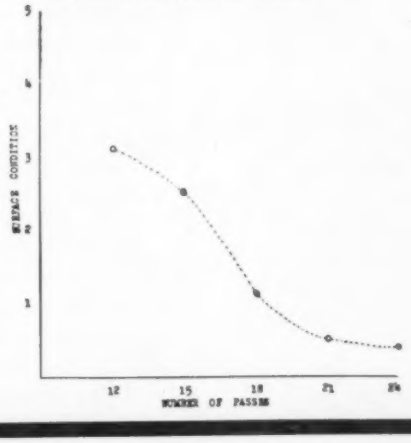


Figure 22 — Surface condition vs number of passes used in blooming mill to reduce ingot.

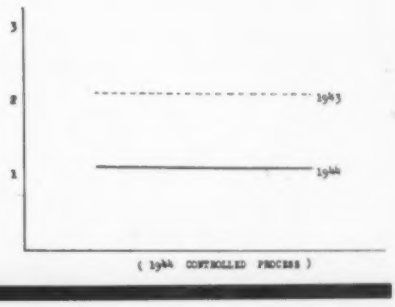


Figure 23 — Process control has resulted in marked improvement of surface condition of the sulphur steels.

depends upon the temperature of the ingots when delivered to the pits. However, considering comparatively hot ingots, a definite standard pit time based on the ingot temperature at charge can be arrived at and should be followed. The importance of thoroughly soaking sulphur steel at a uniform temperature cannot be too strongly stressed. Considering ingots with the recommended track time, the relation of pit time is clearly indicated when a ratio of the two items is studied. From Figure 20, it is evident that the nearer pit time comes to doubling track time, the better the final surface condition will be.

In arriving at the desirable soaking temperature it is necessary to consider rate of temperature increase, pit atmosphere and length of soaking period. Initial slow heating with a "smoky" flame, gradually increasing the rate of temperature rise as higher temperatures are attained, with strict adherence to heating cycles, will insure satisfactory results. Figure 21 indicates the temperature best suited for meeting surface requirements on these types of steel; 2400 F appears to be the temperature best suited to render the metal plastic enough to flow uniformly when subjected to blooming operations. Washed ingots must be avoided.

BLOOMING OPERATIONS

Factors to be considered in the rolling operations on a two-high mill are the amount of draft and the total number of passes. Light initial passes, with an equal amount of work on all sides to break down the skin structure, must be employed to resist surface cracking when subsequent heavier passes are taken. In Figure 22 the effect of bloomer breakdown on the degree of ingot cracks is indicated.

In conclusion it should be noted that no one single factor will guarantee surface quality. Since this is a difficult steel to produce successfully, it is essential that the utmost care be exercised in each phase of production. This care can only come through a thorough knowledge of the best production process, and the personal effort of the men involved. Figure 23 illustrates the improvement resulting from process control during the past year insofar as these types of steel are concerned.

DISCUSSION

PRESENTED BY

H. E. PHELPS, Superintendent, Electric Furnace Department, Rotary Electric Steel Company, Detroit, Michigan

G. A. FERRIS, Process Control Engineer, Ford Motor Company, Dearborn, Michigan

P. E. HAGLUND, Melting Superintendent, Ford Motor Company, Dearborn, Michigan

H. F. LESSO, Control Metallurgist, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

C. E. S. EDDIE, Assistant Superintendent, Power and Fuel, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

L. D. WOODWORTH, Assistant Superintendent, Open Hearth, Carnegie-Illinois Steel Corporation, Youngstown, Ohio

PAUL CARNAHAN, Superintendent, Steel Conditioning, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

W. E. BAYERS, Assistant Chief Metallurgist, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

E. N. HIBBERT, Carnegie-Illinois Steel Corporation, Youngstown, Ohio

JACK DENT, Michigan Seamless Steel Company, South Lyon, Michigan

A. F. DANZER, Superintendent, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

M. L. COVER, Superintendent, Sintering Plant, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

R. E. DIENST, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

H. E. Phelps: Residual copper was mentioned as the worst offender. Is copper worse than tin?

G. A. Ferris: We have not had a great deal of experience with high tin. In fact, the highest I have ever seen is .02 or .03 at the very most, and I have not seen that on sulphur steel.

H. E. Phelps: We find tin far more detrimental than copper, although copper would be the next offender. We have had tin as high as .26. That means a scrap heat.

Of course, our steel was made in an electric furnace, but it is more or less the same as open hearth practice. We used to make a lot of this type of steel before the war, but we found some things that were directly at variance with the experience set forth in the paper.

For example, if we banked the heat and charged cold ingots, we got a far superior surface than an ingot charged hot. The only danger to that was improper heating after banking, or not lowering the pit temperature enough. If they exercised the proper care in dropping the pit temperature and then got a good soak, we would get an infinitely better surface on a banked ingot than we would on one charged hot.

G. A. Ferris: Although we realize that banked ingots can be rolled successfully, if the proper soaking pit practice is followed, we do not find them to be superior to hot charged ingots in our practice.

P. E. Haglund: I have had some personal experience with high tin, and tin is definitely worse than copper. I have known of a heat with a half per cent of tin that would not roll, so I would say tin is far worse than copper.

H. F. Lesso: Have you investigated the influence of residual silicon in combination with sulphur?

G. A. Ferris: Not residual silicon, but we do attempt to keep the silicon as low as the specification will allow, as we have proven this to be an aid to rollability in sulphur steels.

H. F. Lesso: How low?

G. A. Ferris: To .10 per cent and occasionally slightly under. We made one heat of high sulphur steel which we semi-killed in the molds with aluminum, but the results were definitely not favorable. The residual silicon on this heat was .02 per cent.

H. F. Lesso: Do you have any information on the machinability of your sulphur steels with increasing

and decreasing manganese; also, with increasing and decreasing sulphur chemistry? What combination have you found to result in good machinability?

G. A. Ferris: About all I could say in that respect is that since the chemistry has such an important effect on the surface condition, this receives first consideration. However in the particular type of steel I have discussed, which is used for camshafts and subject to considerable machining, we find that approximately 1.25 per cent Mn and .09 per cent sulphur will give the best rolling results, and we have not had any complaints regarding machinability.

H. F. Lesso: Do you suppose the nitrogen content in the metal does influence the dispersion of the sulphide particles? In your plotted results you were able to show a definite improvement in the surface of your steel by increasing the manganese content. Viewing this from the standpoint of certain physical properties of the sulphide compounds involved, it is difficult to interpret accurately, for the reason that iron sulphide has a melting point of 2179 F, whereas manganese sulphide has a melting point of 2498 F. In the binary system of FeS-FeO, there is eutectic at 1724 F. In the MnS-FeS system, there is eutectic at 2158 F. If with increasing manganese a more uniform disperson of sulphide particle does not result, it would appear to me that, with a higher manganese, a more defective surface should result due to the higher temperatures necessary to affect the plastic nature of the manganese sulphides in the metal. This interpretation is obviously incorrect. Can you explain the beneficial influence of the higher manganese?

G. A. Ferris: The theory back of this is that, in the absence of sufficient manganese, the sulphur added to the steel forms iron sulphide which migrates to the grain boundaries in the steel. This iron sulphide, as you have pointed out, has a low melting point and thus at rolling temperatures becomes liquid, causing the steel to crack at the grain boundaries when rolled. This condition is overcome to some extent if the steel contains a large percentage of manganese which permits the formation of manganese sulphide rather than iron sulphide. Since manganese sulphide does not migrate to the grain boundaries and has a higher melting point, as you also pointed out, a more uniform dispersion of sulphide particles does result and thus this condition known as hot-shortness is partially eliminated.

I do not believe the nitrogen content of the metal has any affect on the dispersion of sulphide particles. It is generally agreed, however, that nitrogen does improve machining properties. This improvement is noticeable mostly in tough steels such as low carbon types, and is probably due to the embrittling effect of the nitrogen causing the steel chips to break more easily during the machining operations.

H. E. Phelps: I might add a little to Mr. Lesso's question. In the past, we did quite a bit of work on comparing machinability, and we found machinability varied inversely with the manganese and silicon content and directly with the sulphur. The surface condition is just the reverse.

The higher the manganese and the higher the silicon, the better the surface, and the higher the sulphur, the worse the surface; but machinability in our experience varied inversely with the manganese and silicon content.

C. E. S. Eddie: It was mentioned that the teeming temperature accounted somewhat for surface defects. The temperature difference, I believe, was only around 5 to 10 degrees, causing an increase in surface defects. This close measurement of teeming temperature does not seem very practical. Can you tell us more about this procedure?

G. A. Ferris: I will admit that this is a very close temperature range; however with carefully standardized instruments and trained men we have been able to attain these results. We teem through a dish and do not tar coat our molds, which keeps smoke at a minimum and I believe this tends to make our temperature observations more uniform.

H. E. Phelps: I think I would agree with Mr. Ferris on that. We have no difficulty keeping within a 10 point range.

L. D. Woodworth: How much does the temperature drop from the first to the last part of the heat?

G. A. Ferris: Pouring through a dish, as we do, the temperature drop from the first to the last part of the heat amounts to very little. The temperature drops on the first 8 to 12 ingots, until such a time as the dish nozzles are sufficiently heated. From this point the temperature rises slightly and holds about constant throughout the remainder of the heat. It would not drop over 5 degrees.

L. D. Woodworth: In our experience, we drop from 10 to 30 degrees in heat.

G. A. Ferris: We pour through preheated dishes, which may account for this difference.

H. E. Phelps: Is that tapping or teeming temperature?

G. A. Ferris: That is teeming temperature, as read from the dish.

P. E. Haglund: I might say, you will find quite a little difference between direct pouring and pouring through the dish. Pouring direct, our temperature readings would be in the neighborhood of 2880 or 2900 F. After passing through the dish, it would probably be in the neighborhood of 2800 F, a drop of about 60 to 100 degrees going through the dish.

L. D. Woodworth: You vary 40 degrees going through the dish?

P. E. Haglund: Yes, the variation is probably due to the dish temperature and colder metal in the bottom of the ladle. The average temperature drop through the dish will be about 70 degrees. As Mr. Ferris says, there is a drop after we first start pouring; then after the dish is heated up you have a rise in temperature of about ten degrees, and that remains constant almost throughout the heat.

Paul Carnahan: I should like to ask if you have had any experience with saddening this type of steel. Also whether your surface was improved by saddening?

P. E. Haglund: Yes, we have run some heats through by saddening, and we definitely found it beneficial to do so, but due to our setup, we cannot do it as regular practice.

H. E. Phelps: May I ask whether square molds have ever been tried to avoid that cracking on the corner?

G. A. Ferris: We did. We tried a 26-inch square mold but the results were not satisfactory.

H. E. Phelps: We had no luck with the round molds, but did better with the square molds.

G. A. Ferris: We purchased four square ingot molds to experiment with, and did not get any results as satisfactory as we get with our regular round fluted molds.

H. F. Lesso: Returning to the point Mr. Eddie brought out. We conducted a few experiments attempting to check the consistency of temperature measurements on molten steel made by a number of operators using the same optical instrument. We found considerably greater variation when temperature readings were made on tapping streams than on teeming streams. We found that when measuring the temperature of liquid metal, the variations in the readings taken were substantially less where the filament was focused completely across the body being measured such as in a teeming operation.

A report published sometime ago dealing with temperature measurements of molten metal showed that with eight different operators using one optical instrument and measuring the same body of metal a variation of 40 degrees was reported, but again it was a case where the filament was not focused entirely across the body of metal being measured.

W. E. Bayers: Have you tried any sulphite additions?

G. A. Ferris: We made one heat of low carbon triple alloy steel with an addition of sodium sulphite to improve machinability. Our surface results were extremely poor, and as yet we do not have the results on machining.

W. E. Bayers: In other words, the surface on the product of the sulphite treated ingot was not as good as that on the product of the regular ingots?

G. A. Ferris: No, it decreased our surface quality a great deal.

C. E. S. Eddie: Do the molds have enclosed bottoms?

G. A. Ferris: No, we use open bottom molds.

C. E. S. Eddie: How do you apply residue or surface preparation to the mold?

G. A. Ferris: We dip the whole mold in a graphite and water solution. We have a tank, and lower the molds into it with a crane.

L. D. Woodworth: You mentioned using raw dolomite and roll scale to work your heats. Why raw dolomite?

G. A. Ferris: We have used raw dolomite on various grades of steel. For one purpose, it does contain a base which would be beneficial if your slag might be slightly on the siliceous side. It gives activity to the slag which aids in dissolving any lime that might be there in an undissolved condition. The main thing we found out about it, it creates activity in the slag due to its CO_2 content. It also accelerates carbon drop.

H. F. Lesso: We prefer it to raw lime.

G. A. Ferris: We would prefer it to raw lime. However, in the past week we have used crushed raw lime on one or two heats, and I can't see a great deal of difference. One is probably as good as the other.

H. E. Phelps: You mentioned blocking your heats. Do you ever tap them open?

G. A. Ferris: We tap considerable open steel, but not of this type.

H. E. Phelps: We used to tap high sulphur steel open and block them in the ladle.

G. A. Ferris: On what manganese would that be?

H. E. Phelps: Perhaps .60-.90 per cent and even some of the high manganese.

G. A. Ferris: In making a heat with 1½ per cent manganese, you might run into segregation on that large an addition to the ladle.

H. E. Phelps: We have made a great quantity of this steel, with all of the addition in the ladle — the high manganese grades, too, although our general practice on 1½ per cent manganese is to put the manganese through the furnace just prior to adding silicon. In other words, we add manganese to the furnace and then the silicon in the ladle.

H. F. Lesso: When you tapped your heats early after the manganese addition, did you find any great variation in the manganese distribution throughout the heat?

H. E. Phelps: No, we did not. We found the distribution pretty well taken care of in tapping early if the heat was hot enough to take the manganese, of course.

E. N. Hibbert: I noticed in two of the curves that low residual manganese and high FeO contributed to better surface. A third curve showed that it was also best to block as high in carbon as possible. Isn't this somewhat contrary to the first two findings?

G. A. Ferris: Since recarburizing is detrimental, as I have pointed out, we desire a low residual manganese and a high FeO only in relationship to the proper carbon. In other words, we believe that any advantages derived from going to a lower point in carbon and thus attaining a higher FeO and lower residual manganese would be offset by the extensive recarburization necessary.

L. D. Woodworth: Do you use low carbon ferromanganese?

G. A. Ferris: Yes, we do.

L. D. Woodworth: That might permit a higher tapping than we considered here.

G. A. Ferris: We use low carbon ferromanganese of about 1.4 per cent carbon. We use that exclusively on low carbon steels.

L. D. Woodworth: What deoxidation do you use other than your silicon block?

G. A. Ferris: We add aluminum in the ladle. In this particular type, we add two pounds of aluminum per ton.

W. E. Bayers: Do you find that aluminum addition adversely affects machinability?

G. A. Ferris: I do not have any particular figures on this but it is generally concluded that aluminate or silicate inclusions are detrimental to tool life.

Jack Dent: How is the time determined from the block to the time when you tap your heat? I noticed various times were indicated. I think 30 minutes was about the lowest. Has any smaller interval of time been tried?

G. A. Ferris: We would like to get that down to about 15 minutes if we could, but waiting for an analysis from the laboratory, which requires about 15 to 17 minutes, and the usual operating delays make it about 30 minutes at the minimum. We measure that from the time the silico-manganese is added until the first metal hits the ladle.

Jack Dent: Do you find that in thirty minutes your bath starts to open up in your furnace, particularly around the edges?

G. A. Ferris: Slightly, yes.

Jack Dent: Do you think that is conducive to good clean steel? You are starting oxidation again, are you not?

G. A. Ferris: No, we do not think it is conducive to good clean steel to hold the heat too long after blocking. We attempt to block heats with a minimum of silicon and tap before the slag starts to open up. In other words, get the heat out before reoxidation of the FeO from the slag to the metal occurs.

Jack Dent: Have you tried any method of deoxidation in the mold? Do you think that has any important bearing on the surface condition?

G. A. Ferris: We have not done anything in regard to deoxidation in the ingot molds. We attempt to complete this in the dish with small aluminum additions.

H. E. Phelps: Is it your experience that you get better machinability with a fine grain?

G. A. Ferris: I am far from an authority on machinability, but there is a theory advanced that a fine grain in soft steels is an aid to machinability.

H. E. Phelps: I notice that our customers purchase coarse grain steel if they want machinability.

A. F. Danzer: Is there any one variable that is more important than others, and would that be in the making of the steel or the rolling of the steel? Would you say the rolling of the steel would have more importance than the other variables in the making of sulphur steel?

G. A. Ferris: In my opinion the soaking pit operation is the controlling factor. Sulphur steels of this type must be soaked at a uniformly high temperature for a definite period of time. If this practice is not right, the steel will not roll regardless of other conditions. At the same time, if this practice is right, poorly made heats can be improved.

A. F. Danzer: You would rather stress that than the number of passes that should be used?

G. A. Ferris: Yes, I believe the mill breakdown is only important on well heated ingots. There is very little a roller can do with poorly heated steel.

M. L. Cover: It has been demonstrated that you get very much better results if you take light drafts to start with, and then very heavy drafts while the ingot is still good and hot, and then finish up with some very light drafts again, but do not try to do any work on the ingot after it gets cold. If you do that, you will make a far better surface on it.

G. A. Ferris: We would be inclined to agree with that statement on many grades of steel. However, in regard to sulphur steel, we prefer sufficient temperature to allow light draft all the way through the blooming operation.

H. F. Lesso: Perhaps a likely explanation for the development of serious breakage in sulphur steels could be found in the following diagnosis. Sulphur is naturally in combination with iron as iron sulphide and with manganese as manganese sulphide. The solubility of these materials in the iron grain is open to question. If an ingot is charged into the soaking pit at such temperature that the relatively insoluble sulphide and iron oxide compounds have already migrated to the grain boundaries and subsequent reheating of the ingot body had failed to redissolve these sulphide and oxide particles, their presence in the grain boundaries would naturally represent a plane of weakness and any drastic reduction of the ingot in the mill would result in serious surface rupture, no matter how carefully the ingot may have been heated.

Therefore, I believe surface breakage will develop in accordance with the conditions represented by the distribution or dispersion of the sulphide and oxide particles in the ingot body as influenced by temperature before the ingot arrives at the soaking pit.

L. D. Woodworth: It seems to me you have to consider carbon, also. We all know a .10 carbon high sulphur ingot will roll better than an .18 carbon ingot.

Jack Dent: How is teeming temperature controlled?

G. A. Ferris: As I said, we control it to the best of our ability by tapping hot enough to allow for any operating delays such as moving the ladle from the furnace to the dish, and on occasions when we believe we have tapped a heat excessively hot, we hold it in the ladle for a period of time which we have calculated will give us the required temperature drop so we may pour at what we believe to be the right temperature.

That is difficult and does not always give the desired results. However, we have had fairly good results with this practice. We can also regulate the amount of metal in the dish to an extent to help out temperature control. In other words, we can pour with a full dish, which will help to hold up temperature, or with half a dish if the heat is too hot.

R. E. Dienst: Do you avoid splash in the bottom of the ingot by pouring through the dish?

G. A. Ferris: That is one of the main advantages in using a dish. We teem from a 10-ton dish with 2 stoppers out of a 180-ton ladle, so naturally static pressure is greatly reduced and teeming time is somewhat lengthened, which is also conducive to good surface quality.

Jack Dent: Can these same principles be applied to obtain a good surface on all types of steel, or only this sulphur steel?

G. A. Ferris: The majority of these principles are applicable to all types of steel.

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Relay Protection

FOR STEEL PLANT SYSTEMS

. . . . proper application of protective relays provides protection to all equipment on the system, and offers a means of selectively removing faults without major power outage . . . .

by C. L. Eichenberg

EXPERIMENTAL ENGINEER

BETHLEHEM STEEL COMPANY

BETHLEHEM, PENNSYLVANIA

▲ THE expansion of many steel plant power systems during the current emergency, coupled with the importance of maintaining uninterrupted production, has placed a new emphasis upon the application of protective relays. Developments in relay design have kept pace with the increased demands placed upon most power systems to supply reliable service. These improvements have made it possible to apply protection with the utmost confidence in the ability of the relays to operate correctly when called upon.

The purpose of any protective relay is to detect a fault condition which may exist within the protected circuit and to remove that fault by tripping the minimum number of breakers. The latter part of the above statement, "remove the fault by tripping the minimum number of breakers," is termed selectivity. To operate successfully, a relay system must be selective; otherwise, a fault on one line may unnecessarily trip breakers far removed from the faulted zone and thus result in delays and loss of production.

It is the purpose of this paper to describe a moderately large steel plant power system and illustrate how the problem of relay protection for this system was solved. The power system in question was originally built about 30 years ago and operated at 6600 volts, 25 cycles, ungrounded. During the subsequent years of growth, additional generating capacity was added and the number of ties with the local utility were increased. The total capacity of the enlarged system is at present 120,000 kva, to which is connected 39,000 kva in synchronous machines. It is needless to say that such a growth in system capacity, as well as the increased number of synchronous machines, has imposed a heavier interrupting duty upon all the circuit breakers in the plant. So great is the short-circuit capacity of the system that the interrupting ability of many of the smaller outlying breakers is exceeded.

It was not economically feasible nor otherwise possible to replace those breakers whose interrupting capacity had been exceeded, since much of this growth was the result of increased war production. The best solution to this problem was the application of proper relaying which would be sufficiently selective to allow the lighter duty breakers to clear faults within their rating but trip the heavier duty back-up breakers whenever a major fault occurred. It was also desirable that the relay protection provide high speed selective tripping for all the major components of the transmission system in order to minimize damage to insulators, bushings, bus structures, etc.

The original transmission system of this plant consisted of a loop which passed through five substations. The substation of origin was connected to the local utility by means of a 7500 kva bank of transformers and to the plant power house by two parallel feeders.

Presented before A. I. S. E. Philadelphia District Section Meeting, November 4, 1944.

The relay protection afforded this system consisted of plunger type relays which were applied to the tie lines and to the loop transmission lines at the station of origin. At the latter point these relays were supplemented by polyphase directional relays. The only protection afforded the intermediate sections of the loop consisted of balanced-current plunger type relays which were applied to the parallel conductor type of line construction that was so widely used at that time.

The selectivity of this early relay system was very poor. While the balanced-current relays would selectively remove line faults, all other classes of faults, such as bus failures or machine failures in the substations, would result in tripping the relays at both ends of the loop and the consequent shutdown of the entire power system.

As additional generating capacity was added and the system expanded, the need for improved relay protection became apparent. Consequently, the old relays were abandoned in favor of the induction-type relay and a new system was installed.

The new relay setup consisted of directional-type relays which were applied to each section of the loop and to the tie lines. The accurate gradation of operating times possible with these relays afforded the system a certain measure of selectivity and resulted in improved operation and a decreased number of shutdowns.

As previously stated, expansion of the productive capacity of the plant made additional power facilities mandatory. A portion of the expansion program consisted of a relay study with the object of improving the selectivity and reducing the relay operating time when clearing line faults. The result of this study was a decision to add high speed pilot wire relays to all the main transmission lines and to revamp the protection of all feeders in order to safeguard the lighter duty breakers.

A schematic diagram of the expanded power system to which this protection was applied is shown in Figure 1. It will be noted that the lines and substations comprising the system are arranged in the form of a major loop with generation and utility ties made at five different points. The major loop in turn is tapped to form a minor loop which feeds an important load center somewhat removed from the main plant. The average distance between stations on the major loop is one-half mile, while the minor loop is about three miles in circumference.

All of the lines comprising the major loop, as well as four tie lines to sources of generation, were equipped with pilot wire relays as shown by the solid lines in the diagram. Back-up protection for each of these lines consisted of the directional-type induction relays which had been in use previously. The minor loop was equipped with directional relays only, but provisions were made to supplement this protection by adding pilot wire relays in the future.

The directional relays were retained in order to provide protection against bus faults in those stations not equipped with bus differential relays, to remove faulted lines in case of pilot wire relay failure, and to clear faults which might originate on the public utility's system.

PILOT WIRE RELAYS

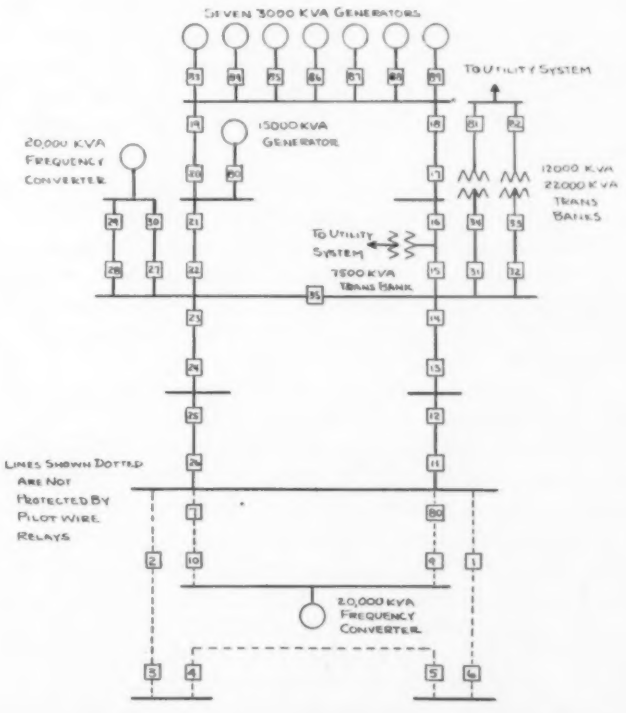
Pilot wire relays as applied to the protection of transmission lines are not new; in fact there are many power systems that have had some form of pilot wire protection in operation many years. The older forms of pilot wire relays required three or four pilot conductors of low resistance, and often times they were characterized by lack of sensitivity and high burdens on the current transformers. The d-c pilot wire relay which was developed in order to overcome these limitations met with some success, but it possessed certain disadvantages such as the need for a constant source of d-c potential, the effect of out-of-step conditions on relay operation, and the inability to insulate the relay from the pilot wires.

The recent introduction of the two-wire a-c pilot wire relay has overcome all of the disadvantages of the former relays and has made available simplified pilot wire protection. There have been installed in the steel plant in question two different types of two-wire a-c pilot wire relays of different manufacture which operate on different principles but produce the same results.

The first type of relay, illustrated in Figure 2, shows that the three currents from the current transformer secondaries at one end of the protected circuit are transformed into an equivalent single phase current in the auto-transformer. Current from the auto-transformer is used to energize the input transformer in series with the polarizing winding of the relay element. The secondary of the input transformer feeds the pilot wire which is connected in series with the operating winding. The restraining winding is connected in shunt across the secondary of the input transformer. The relay at the opposite end of the line is connected in an identical manner.

When a through-type fault occurs, the voltages pro-

Figure 1 — Schematic diagram of 25 cycle steel plant power system with a major and a minor loop.


SEVEN 3000 KVA GENERATORS
TO UTILITY SYSTEM
15000 KVA GENERATOR
20,000 KVA FREQUENCY CONVERTER
12000 KVA 22000 KVA TRANS BANKS
TO UTILITY SYSTEM
7500 KVA TRANS BANK
LINES SHOWN DOTTED ARE NOT PROTECTED BY PILOT WIRE RELAYS
20,000 KVA FREQUENCY CONVERTER

duced by the pilot wire relays at opposite line terminals produce pilot wire voltages in opposition to each other, which in turn permits no current to flow in the pilot channel. The voltage output of each relay, however, is applied to the restraint winding of that particular relay, which in turn reacts with the polarizing element in such a manner as to hold the contacts open.

When an internal fault occurs, the voltages produced at opposite ends of the protected line become additive and thus circulate a comparatively large current over the pilot wires. This circulating current must pass through the operating coils of each relay. The winding of the operating coil is proportioned in such a manner with respect to the winding of the restraint coil that the torque produced by the operating coil overcomes the torque produced by the restraint coil, and as a result the relay closes its contacts.

This relay offers complete protection against positive, negative and zero sequence faults, and simultaneously trips the breakers at opposite ends of the line when power is fed into the fault from both ends. The operating time for all classes of faults varies from one to three cycles.

The continuity of the pilot wire is of the utmost importance with this relay because an open circuit would prevent passing current through the operating coils and would result in blocking operation. On the other hand, short-circuiting the pilot wires increases the current through the operating coils which results in the relay operating as an overload device.

The second type of pilot wire relay, illustrated in Figure 3, shows the three-phase currents from the current transformer secondaries at one end of the line passed through a positive and zero sequence filter which consists of a three-winding reactor and two resistors. The voltage output of the filter is fed to the primary of the saturating transformer. The secondary of the saturating transformer is impressed upon the pilot wire through a series rectifier. A second rectifier is shunted across the pilot wire. The output of the series rectifier energizes the restraint winding of the relay, and the output of the shunt rectifier energizes the operating winding. Polarization is supplied by a permanent magnet. The relay at the opposite end of the line is connected likewise.

When a through-type fault is experienced, the voltage output of the saturating transformers at opposite ends of the line are additive and thus circulates a current over the pilot wires. This circulating current produces a d-c output from the series rectifier, which is applied to the restraint winding and results in the relay holding its contacts open.

When an internal fault occurs, the voltages produced at opposite ends of the line are in opposition. This results in all of the current flowing through the operating and restraining coils in series and none through the pilot wires. Again the operating coil is proportioned in such a manner as to produce a torque which overcomes the torque of the restraining coil and results in the relay closing its contacts. This relay, too, offers complete protection against all types of faults and provides simultaneous tripping of circuit breakers at opposite ends of a faulted line in about one cycle.

The continuity of the pilot wire channel of this relay is likewise of great importance. A short-circuited pilot wire shunts out the operating winding and causes the total output of the saturating transformer to be applied to the restraint element, thus blocking operation. An open-circuited pilot wire places the restraining and operating elements in series and causes the relay to operate as an overload device.

INSTALLATION OF PILOT WIRE RELAYS

The installation of these pilot wire relays did not present any especially difficult problems. Securing suitable pilot wire channels between the various stations was the item of greatest concern.

There are three methods whereby pilot wire channels

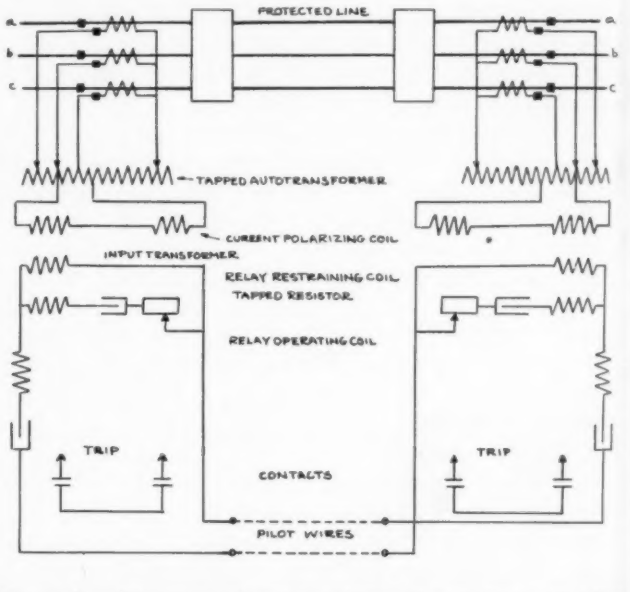
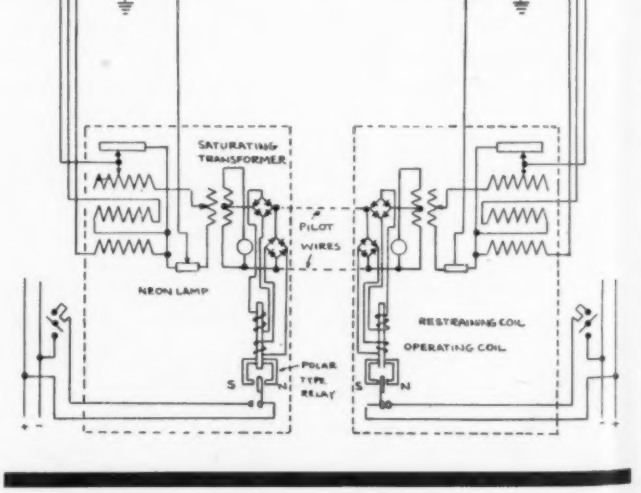


Figure 2 — Diagram of connections of one type of pilot wire relay used in system shown in Figure 1.

▲

Figure 3 — Diagram of connections of second type of pilot wire relay used in system shown in Figure 1.



may be secured. The first method is by suspending an open wire line between stations, the second method is by leasing telephone wires, and the third method is by installing a privately owned cable line. The open wire line was not deemed advisable because the induced voltages might present difficulties in securing proper relay operation. The leased telephone lines are free of induced voltages, but since they are not under the jurisdiction of the power system operators, inconveniences may be experienced while making tests. The privately owned cable presents none of the aforementioned disadvantages and was the device chosen to provide pilot wire channels for this system.

The pilot wire cable installed consists of three pairs of No. 14 wire, cambric insulated and covered by a lead sheath. It is supported from a steel messenger cable and follows the route taken by transmission lines on one side of the loop. The maximum number of wires used on any section of cable is four, leaving two wires as spares which can be utilized for communication purposes while testing.

Each pilot wire channel terminates into the primary of a telephone-type transformer which serves to insulate the relays from any high voltage which might stray in on the cable. The primary of this transformer is split in order to accommodate the automatic supervisory equipment.

PILOT WIRE SUPERVISION

In describing the operation of the pilot wire relays, emphasis was placed upon the effects produced by short-circuited or open-circuited pilot wires. In order to insure correct operation at all times, it is necessary that some means be provided whereby the condition of these wires may be determined. Both types of pilot wire relays are equipped with supervisory instruments as an inherent part of the installation.

In the case of the one type of relay used, a voltmeter and switch is provided whereby the operator can measure the voltage produced by the relays at the near and far end of the line. Equal voltages indicate a clear pilot channel and correct relay operation. Unequal voltages indicate that trouble exists either in the cable or the relay.

In the case of the second type of relay used, a milliammeter and switch is provided whereby the operator can measure the current circulated over the pilot wire by the relays at the near and far end of the line. Again, equal meter readings indicate that the pilot channel is clear and the relays are functioning correctly, while unequal readings indicate trouble. This manual method of supervision is not very effective, since too much reliance must be placed upon the operators to read the supervisory instruments periodically. Also, it is possible for a pilot wire failure to occur between readings and thereby result in false relay tripping or blocked operation. Since the cable line is the most vulnerable part of a pilot wire installation, some means must be provided to automatically supervise it at all times.

Automatic supervision of the pilot wire relay system being described is accomplished by continuously circulating a small direct current over the pilot wires. Figure 4 shows the supervisory relays connected in the middle of the primary winding of the insulating transformers. A d-c voltage supplied by the rectifier circulates current through a series circuit consisting of the coil of the polarized sending relay, the pilot wires, and the coil of the polarized receiving relay. Capacitors provide a path for the a-c pilot wire current to by-pass the supervisory relays, and the transformer insulates the pilot wire relays from the d-c supervisory current.

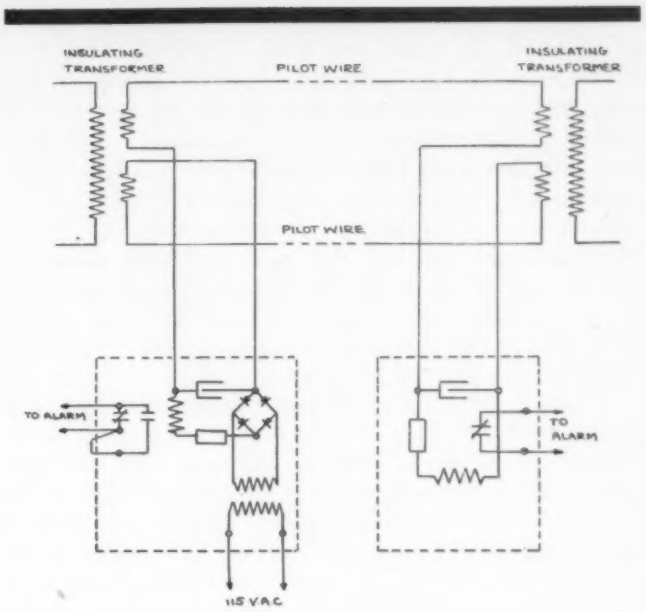


Figure 4 — Schematic diagram of supervisory relay connections used on pilot wire channel.

A normal pilot wire permits the supervisory current to flow at a predetermined value through the series circuit. This current causes the armature of the sending relay to assume a midpoint position and the armature of the receiving relay to assume the full open position. Both of these positions hold the relay contacts open.

An open-circuited pilot wire interrupts the flow of supervisory current to both sending and receiving relays, which results in the closing of their contacts and the sounding of an alarm.

A short-circuited pilot wire by-passes the supervisory current around the receiving relay but increases the current through the sending relay. The effect of this condition is to cause the receiving relay to close its contacts due to lack of torque. The sending relay moves to the extreme position of its travel occasioned by the increased current flow. Operation of both of these relays closes their contacts and again sounds an alarm.

RELAY SETTINGS

Much study was given to the matter of selecting the proper relay settings to be applied to this power system. The pilot wire relay settings presented no difficulties whatsoever, since they clear only internal faults and are insensitive to all through faults. The directional relays, on the other hand, required much tedious work in order to provide selective operation.

All of the pilot wire relays are set to operate when a differential of 16,500 kva is noted between the sending and receiving end of the protected line. This results in

maximum sensitivity and quick clearing of all classes of faults.

Reference to Figure 1 shows that the section of line between breakers 15 and 16 is tapped by a 7500 kva bank of transformers, and that the tapped section is not provided with pilot wire protection. Since these transformers are utilized on rare occasions, it was not deemed necessary to provide compensation to the relays at either end of the line. The pick-up setting of 16,500 kva permits the transformers to be utilized to their full capacity, although a fault beyond the bank would appear to the pilot wire relays as an internal line fault and result in tripping breakers 15 and 16.

As previously stated, the settings for the directional relays involved a considerable amount of tedious work. A short circuit study of the system was made in order to obtain information on the maximum kva that could flow into a solid three-phase short circuit at any point within the system. Using this information, the relay settings were graded in order to obtain the desired selectivity.

These settings were made on the assumption that normal conditions would always prevail — that is, with all sources of power connected to the system. Any radical departure from this normal condition may affect the selectivity somewhat, but since the most important lines are protected by pilot wire relays, it is not expected that the directional relays will be called upon to operate except in cases of bus faults.

Relay settings for all of the stub feeders were made on the basis of the maximum loads to be carried. Since the short circuit study revealed that some of the outlying breakers, which control transformer banks and mill drives, would be called upon to interrupt fault currents in excess of their ratings, all of the feeder relays were equipped with instantaneous attachments. These instantaneous attachments are set to provide instantaneous tripping of the feeder breaker in the power station whenever the fault current exceeds the interrupting capacity of the smallest breaker on that particular feeder. The definite minimum time characteristic of the induction-type relays applied to the outlying breakers, coupled with slower breaker operation, provides sufficient time delay to allow the instantaneous attachments to trip the higher speed feeder breaker.

The relays which protect the ties with the local utility are set to provide selectivity with the utility's relays when faults occur on their lines. These relay settings were also graded in order to provide clearing of faults at attended stations rather than unattended stations. Thus, when a fault occurs beyond the transformer banks fed by breakers 33 and 34 (see Figure 1) in an unattended station, breakers 31 and 32 are tripped in an attended station. Such an arrangement results in more efficient system operation by permitting immediate reclosure of a tripped breaker after the cause of the fault is removed.

SUMMARY

The power system is the lifeline of every steel plant. Continued production demands that power interruptions be held to a minimum and that important electrical apparatus be protected from faults of an electrical nature.

The proper application of protective relays to a steel plant power system not only provides complete protection to all electrical equipment associated with it, but it also provides means to selectively remove faults without effecting a major shutdown.

DISCUSSION

PRESENTED BY

E. L. ANDERSON, Superintendent, Electrical Department, Bethlehem Steel Company, Johnstown, Pennsylvania

C. L. EICHENBERG, Experimental Engineer, Bethlehem Steel Company, Bethlehem, Pennsylvania

A. D. HOWRY, Plant Electrical Engineer, Alan Wood Steel Company, Conshohocken, Pennsylvania

W. H. BURR, Superintendent, Electrical Department, Lukens Steel Company, Coatesville, Pennsylvania

W. G. HARTLE, General Electric Company, Philadelphia, Pennsylvania

M. B. ANTRIM, Assistant to Superintendent, Electrical Department, Lukens Steel Company, Coatesville, Pennsylvania

W. A. SMILEY, Electrical Engineer, Bethlehem Steel Company, Steelton, Pennsylvania

H. H. ANGEL, Assistant to Electrical Superintendent, Bethlehem Steel Company, Soarrows Point, Maryland

F. C. SCHOEN, Plant Engineer, The Midvale Company, Nicetown, Philadelphia, Pennsylvania

E. L. Anderson: I would like to ask Mr. Eichenberg if the pilot wire relay operating on an ungrounded system will clear a phase fault to ground on a single phase, or in other words, is it necessary to have two grounds on the system before securing relay operation on phase to ground faults.

C. L. Eichenberg: Pilot wire relays will not clear a grounded line on an ungrounded system. Two ground faults on opposite phases would be necessary in order to secure relay operation.

A. D. Howry: Has any consideration ever been given to changing to a grounded system, and the use of the carrier current instead of the pilot wire?

C. L. Eichenberg: We have made a thorough investigation of the advantages to be gained by grounding our power system. As soon as conditions permit, we will carry out our plans to ground the system.

No consideration was given carrier current relays when our relay system was revamped. Essentially, carrier current and pilot wire relays perform the same function. The former are used where the length of line to be protected is so great that the pilot wire resistance is too high to enable pilot wire relays to afford reliable protection. Since the maximum length of any protected

line section in our plant is less than a mile, pilot wire relays were chosen as the most economical form of protection.

W. H. Burr: What method is used to instruct substation operators who are unfamiliar with this complicated system, and what method is used in working up the settings on the various relays in order to get the proper protection?

C. L. Eichenberg: The substation operators in our plant receive all their orders from a load dispatcher who is familiar with all the forms of relays used on the system. This method of giving orders to the operators relieves them of all responsibility for using good judgment and enables us to carry out switching orders according to prearranged schedules.

The relay settings were calculated with the cooperation of the manufacturer's engineers. These settings may be changed from time to time in order to meet local conditions.

W. G. Hartle: I would like to ask Mr. Eichenberg what type protection he uses for his transformers and major rotating equipment, such as generators and large synchronous equipment.

C. L. Eichenberg: All of our major rotating equipment is protected by percentage differential relays to guard against internal faults. Large motor drives are provided with phase balance relays as additional protection to guard against open-phase operation.

Transformers are generally protected by straight induction-type overload relays only.

M. B. Antrim: Is there a blocking rectifier ahead of the receiving relay used with this system, or is it impervious to picking up a-c currents in the pilot wire? Concerning the a-c testing of the pilot wire relay, we have a pilot wire relay system which uses an iron wire circuit due to priority regulations. The voltages at each end of this system when tested at one end are quite different. We have not quite figured out what this means to the operation of the relay and would be glad to have any suggestion that might be offered.

C. L. Eichenberg: The a-c current which flows over the pilot wire relay does not affect the d-c supervisory relays because it is by-passed by a capacitor across the midpoint of the insulating transformer. We found it necessary in one case to increase the value of this capacitor to keep the a-c out of the supervisory relay.

The difference in voltages between the local and remote ends of a pilot wire system as mentioned by Mr. Antrim is quite common. Generally, the voltage at the local end is higher than that of the remote end, since reading of the remote voltage inserts the resistance of the pilot wires plus the impedance of the two insulating transformers in series with the voltmeter, whereas the local end voltage is read directly from the output of the relay. However, differences in the characteristics of the current transformers and their burdens may also introduce slight differences in the voltmeter readings.

W. A. Smiley: There is one point which I would like described further. How are negative sequence components due to normal operation distinguished from those produced under faults which require breaker tripping?

C. L. Eichenberg: Negative sequence components due to normal operation are distinguished from those produced under faults by the directional comparison characteristics of the relay. A negative sequence load on a transmission line will not cause relay operation if the magnitudes of the current at the sending and receiving ends of the line are equal and flow in the same direction.

A negative sequence fault is detected by the difference in magnitude and direction of current flow between opposite ends of a line.

H. H. Angel: We have a very large power system in our plant at Sparrows Point. We have about 35,000 kw from the Consolidated Gas, Electric Light and Power Company of Baltimore on 25 cycles, which is tied in with our powerhouse which has a capacity of about 50,000 kw, and that in turn is tied in at the tin mills with a 20,000 kw frequency changer. On the 60 cycle system, which is all purchased power, we now have around 50,000 incoming kw. We are always endeavoring to improve the feeder performance to obtain greater selectivity. We have only one 25 cycle division which uses pilot wire relaying; that is between the powerhouse and sections of our tin and sheet mills and it has been working since 1937. I might say that we think an awful lot of it, because at times when lightning strikes the lines it may just take a chip off some of the insulators and the circuit opens in a very few cycles before any real damage is done.

We also know from experience that occasionally a locomotive crane may strike a line and sometimes the damage to the feeder is confined possibly to one or two burned strands. But that, as I mentioned before, is only part of the system. One of the most important things confronting us is the continuity of power. If you have some kind of a short circuit, either on the bus or on a piece of rotating equipment, you want that piece of equipment disconnected from the source of power in the smallest amount of time to prevent a power outage, either in that substation or in the powerhouse. That is one of our greatest problems and we are always endeavoring to improve that condition by better relaying.

C. L. Eichenberg: Mr. Angel brought out one very pertinent fact. That is the ability of pilot wire relays to remove a faulted line section in a few cycles as compared to much longer times required by other forms of selective relaying. This rapid tripping of breakers during a fault has minimized the damage to lines, insulators, bushings, etc., as well as preventing the loss of much important synchronous equipment that formerly tripped when the duration of a fault was extended by slower relaying.

F. C. Schoen: Mr. Eichenberg spoke of by-passing breakers when the load they had to interrupt was beyond their capacity. From the diagrams I do not see how it was handled by the pilot wire system. I would like to know the arrangement to take care of a fault larger than the capacity of a breaker.

C. L. Eichenberg: The pilot wire scheme does not provide a method of by-passing small breakers when they are called upon to interrupt a fault in excess of their capacity.

When the smaller breakers on our system are called upon to interrupt a fault in excess of their capacity, the main feeder breaker in the power station is tripped instantaneously and thus relieves the smaller breaker of the heavy load.

DEVELOPMENTS IN

Rotary Hearth Furnaces

. . . . the application of rotary hearth furnaces has increased amazingly in the past few years . . . . the design offers a number of advantages which should lead to further adoption . . . .

by J. H. Loux

SALEM ENGINEERING COMPANY

SALEM, OHIO

▲ IN preparing a paper on rotary hearth furnaces it was necessary to consider every design of rotary furnace on the market today. Because there are almost 50 furnace companies reporting to the Industrial Furnace Manufacturers Association, there are just about 50 different engineering departments designing rotary hearth furnaces. Furthermore, many of these companies build four or five types of rotaries, depending upon the heating problem involved. As a result, it can truthfully be said that there are over 200 distinctly different rotary hearth furnace designs in existence today. A paper discussing the competitive values of each of these designs would, no doubt, be educational. But it is believed that a discussion of why a rotary furnace is used and what its advantages are over other types of furnaces will be of more interest than would a consideration of details of competitive designs.

A study of the five basic applications for rotary hearth furnaces will give a fairly complete answer to why rotary furnaces have met with so much favor within recent years.

The first type, known generally as the pan-dumping rotary, is constructed with an alloy hearth supported on a shaft extending up through the center of the furnace. The hearth is made in sections and each section is formed into a tray. These trays are hinged so that the material on them may be dumped into a chute extending through the bottom of the furnace into a quench tank. The furnaces may be designed with direct-fired oil burners, gas burners, radiant tubes or electric heating elements.

To charge a furnace of this type, a small pan with a removable bottom is used. This pan, loaded with material, is pushed through the charging door onto one of the hearth trays. The bottom of the pan is pulled out first which allows the material to settle into the hearth tray. The balance of the charging pan is then raised clear of the material and removed from the furnace.

There are certain pieces of material which will not quench properly from a standard chain belt conveyor hardening furnace. One example would be lockwashers. These lockwashers when placed on a belt or on a vibrating hearth have a tendency to hook into one another. By the time they reach the discharge end of the belt or hearth, they have linked themselves together into short sections of chain which hang down almost into the quench tank. This produces an extremely inconsistent product and necessitates very close inspection of the finished work.

Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pa., Sept. 25-27, 1944

By loading the lockwashers on the individual tray sections of a pan-dumping rotary, an entire group of washers is quenched at one time. If the parts link together it makes no difference whatsoever in the uniformity of treatment.

This pan-dumping rotary is especially adaptable to the use of a protective atmosphere for scale-free hardening or annealing. It is also very convenient to locate two quench tanks beneath such a furnace and to put oil in one tank and water in the other tank. The furnace can be equipped with two doors and run in one direction when dumping material into the oil quench and run in the opposite direction when dumping material into the water quench. Either door may be used for charging or discharging.

Another type of rotary to be considered is one that is required to handle a miscellaneous assortment of plates and bars for forging, plus some welded sections for annealing. Rotary furnaces have been used for many years to heat plates. Ordinarily, the plates are laid directly on the furnace hearth by means of tongs and removed in the same manner. On one recent application it was necessary to investigate the handling equipment for loading and unloading the plates even more thoroughly than it was to carry on an extensive search for the proper type of furnace.

The particular problem here was to heat 50 plates per hour, 13 in. wide x 5 ft long, from cold to 2200 F prior to forming them into one-half of a banjo type truck axle. No particular heating cycle was required. The plates were merely to be brought up to temperature and placed in a press which would form them into their proper shape.

The automatic charger which was finally developed for this job consisted of a moving peel which pushes into the furnace through one large door, carrying a cold plate in on top of it. This cold plate slides beneath a pair of hinged prongs extending inside the furnace proper. These prongs are arranged to latch behind the plate as it reaches the fully charged position. When the charging peel is withdrawn, the prongs prevent the plate from moving. As a result, the peel slides from underneath the plate, allowing it to drop down onto the furnace hearth.

To make the unit still more automatic, bottom hooks were designed on the end of the charging peel. When the peel is fully in the furnace, these hooks grip the inside edge of a hot plate on the hearth and drag this plate out as the peel moves out. A hot plate is discharged, therefore, at the same time a cold plate is being charged.

It was not especially desired to use a rotary furnace for this job. The rotary was selected because it offered the simplest means for conveying thin sheets at a temperature of 2200 F. Furthermore, a single door, through which these sheets could be loaded and unloaded, was easily adapted to this type of furnace.

There has been much discussion regarding the advantages and disadvantages of using single doors for rotary hearth furnaces as compared to using two doors. The single door in this particular case was a necessity. It has, too, the advantages of presenting less heat loss and of requiring less initial investment.

The special disadvantage, as brought out by many users, is that there is not enough room for two men to work through a single door. It is believed, therefore, that if the product and production is such that one man or one automatic charging unit can load and unload the furnace, a single door would be advantageous. If two men must work around the furnace, two doors are preferred. Whenever it is necessary to keep the cold material entering the furnace at some distance from the hot steel ready to be discharged, the use of two doors is, of course, mandatory.

Many rotary furnaces are used for annealing and are not required to heat to forging temperatures. In these cases an alloy plate hearth is generally set on top of the refractory hearth and the parts to be treated are loaded directly on these alloy plates.

These furnaces have not been as successful as the all-refractory hearth rotary forging furnaces. The alloy hearth requires frequent replacement at great cost. The parts being treated have a tendency to shift on the hearth as the furnace revolves, and unless a rail or lip is cast along the edge of the alloy plates, the parts occasionally drop down into and jam the rotating sand seal.

Some furnace manufacturers build rotary units of this type with sand seals and others recommend water seals. Generally, it is found that the user of a sand-sealed

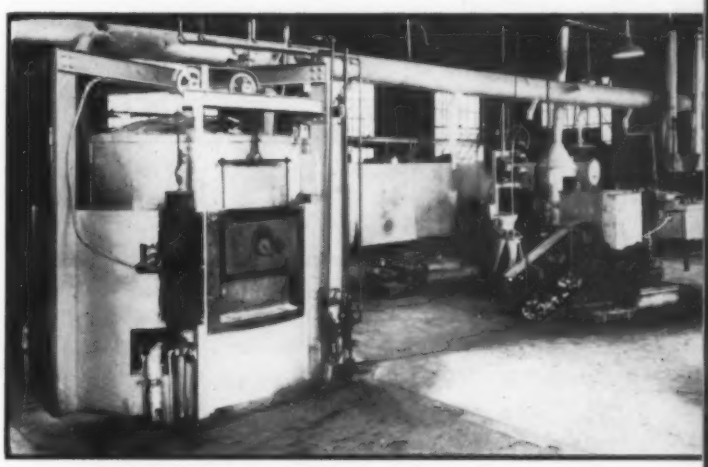


Figure 1 — Direct-fired, alloy-hearth, pan-dumping rotary furnace using two quench tanks.

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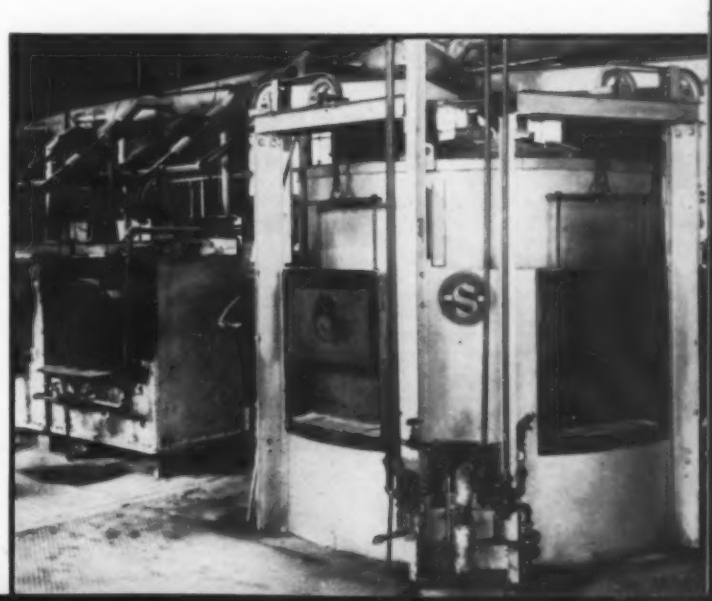
Figure 2 — View of pan-dumping rotary furnace with two doors.



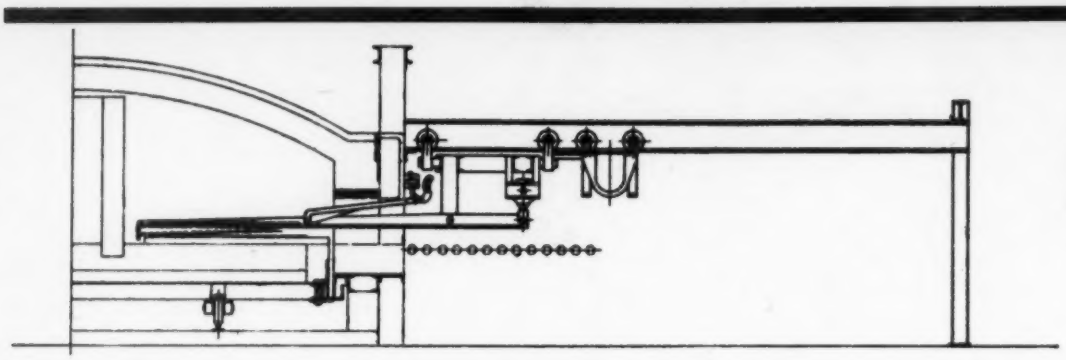


Figure 3 — Sketch showing arrangement of automatic charging and drawing unit for plates.

furnace will stand one hundred per cent behind his selection, whereas the user of a water-sealed furnace will insist that his choice was correct. There is no question but that it is more difficult to keep a seal water-tight than sand-tight. The claim is made that a higher pressure can be maintained within a furnace with a water seal than with a sand seal. The water seal may be ruined in case of water failure and there is always the problem of moisture.

It is believed, however, that unless conditions are very exceptional, any protection that is offered by a water seal can be duplicated by a sand seal, and vice versa.

A third type of rotary is known as the rotary end-heating furnace. The particular unit illustrated was required to heat only 33 in. of 54 in. x 2 in. diameter bars for rolling into leading and trailing edges of airplane propeller blades. At first it was thought that a standard "pigeon hole, shell nosing" type rotary could be used, but it later developed that odd shapes of steel would occasionally have to be heated in this same furnace. This meant that the furnace would have to be designed with a continuous slot all the way around, and with a flat hearth to support any shape or size of piece that might be laid upon it.

The walls and dome of the furnace were hung from an overhead framework. A circular rail, fastened to the bottom structure of the rotating hearth, was carried on a series of stationary wheels. The hearth was held in place by means of a center bearing.

The effective loading diameter of the rotating hearth was 10 ft. The furnace capacity was estimated to be 4000 lb per hr and the unit has consistently maintained this production rate.

The water-cooled beam which forms the top of the slot serves two distinct purposes. First, it provides the means for supporting the furnace wall. Second, it helps prevent heat from feeding back along the bars past the limit to which they are supposed to be heated.

When the furnace was first installed, this large slot opening was not sealed in any way. In spite of the flues built up through the sidewalls of the furnace, it was known that a considerable quantity of air would leak in through the slot and possibly scale the work. This proved to be the case. As a matter of fact, there were times when air currents in the shop actually seemed to blow through the slot and sweep across the furnace hearth. The scale was so heavy the forging would not pass inspection.

The remedy, of course, was to install a seal all the way around the slot except at a point where the furnace was loaded and unloaded. This remedy was so effective that the user of this particular furnace now claims that, with the burners set to produce a smoky atmosphere, the scale is so light it does not interfere in any way with the forging operation.

It is believed, therefore, that such a furnace is very practical for heating the ends of bars when a seal can be provided. If the bars are extra long, if they will extend so far out of the furnace as to prevent the installation of a seal, then this slot type furnace should not be recommended. The scale will definitely be excessive.

Figure 4 — Rotary furnace designed for end-heating. Dome and walls are suspended from above.

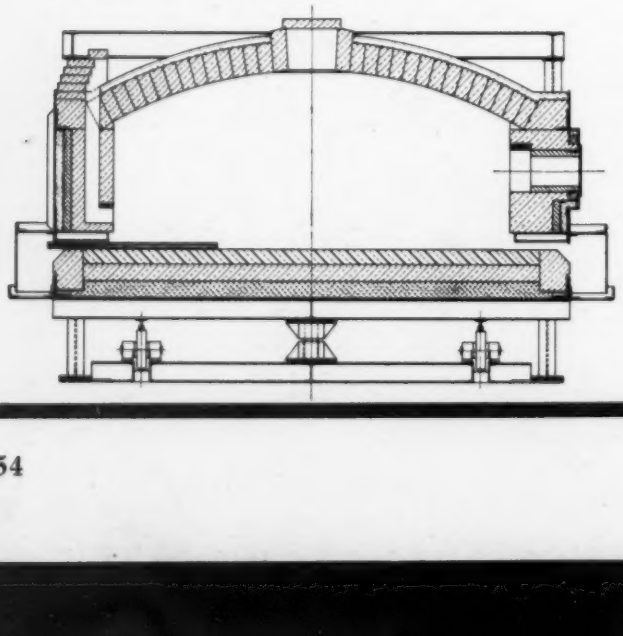
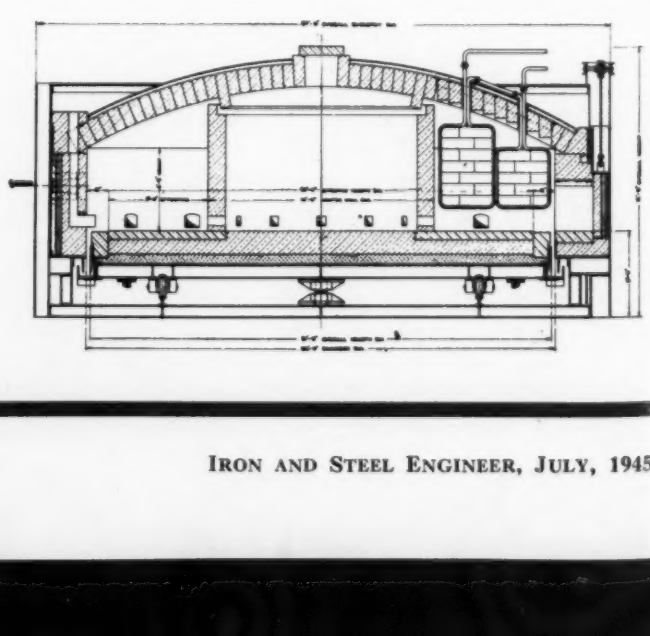


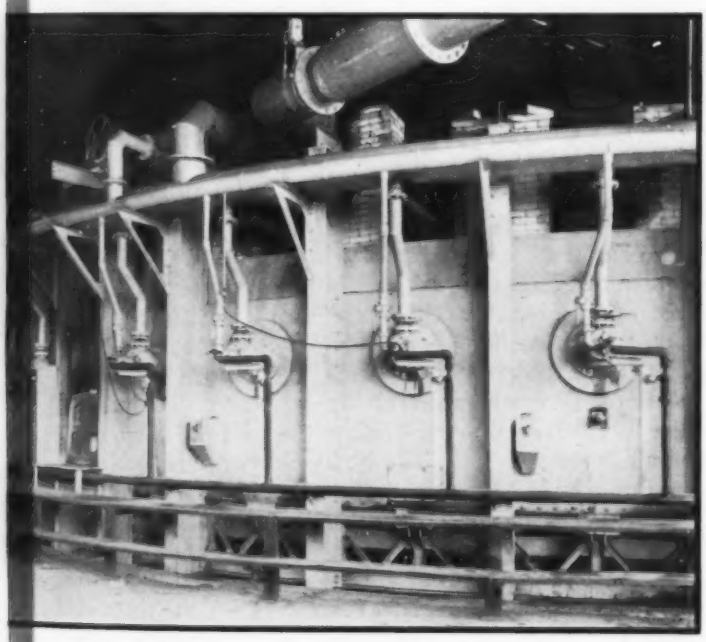
Figure 5 — Rotary forging furnace of standard design.



A still further advancement along this line, and one that appears to have great postwar possibilities, is a rotary furnace that actually heats steel billets and bars to forging temperature without forming any scale whatsoever. At the same time, the surface of the steel is prevented from decarburizing. This involves the use of sealed, gas-tight muffles made of silicon-carbide to withstand the forging temperature. A protective gas, consisting of 98 per cent nitrogen, is fed into these muffles continuously, maintaining a slight positive pressure.

The muffles, cast in tubular form for durability, about 18 in. in diameter and 4 or 5 ft long, are placed radially on a rotating hearth. Each muffle is equipped with a door that extends out beyond the face of the rotating hearth. When a muffle is indexed to the unloading position, a stationary mechanism engages the door and raises or lowers it as desired. The door is closed after each bar is removed, and the nitrogen flow increases when the door is open. After all of the steel bars or billets have been removed from one muffle, the furnace hearth is revolved far enough to reach the adjacent muffle.

The general construction of these furnaces is similar to the rotary end-heating furnace, with the walls, burners and furnace dome all supported and hung from an overhead framework.



The fourth type of rotary furnace is the one most commonly known to all furnace engineers. It is the standard rotary hearth furnace of the "table" or "doughnut" type used for heating prior to forging. It is constructed with a hearth of refractory materials only, and it is never called upon to do any annealing or heat treating.

The most common use of this furnace in recent years has been to heat steel blanks prior to forging them into high explosive shells. For this heating operation, rotary furnaces have proved more uniform, faster and more efficient than the standard pusher type. The basic reason for this is that in a rotary furnace the billets are set on end and separated one from the other. With the billets in this position 80 to 90 per cent of the surface area of the billet is exposed. In a pusher type furnace, firing above the steel only, less than 40 per cent of the surface of the billet is exposed. Naturally, when the heat is allowed to penetrate the billet from all sides and from one end, the rate of penetration is much more rapid than when heating from one side only.

There are a number of design features incorporated in furnaces of this type that affect the production and life of the furnace. A furnace rated at 10,000 lb per hr can, on occasion, double this heating rate for a short period of time. This necessitates operating the furnace with a high temperature head, resulting in poorly heated steel and a serious shortening in the life of the furnace refractories. Unfortunately, there is absolutely no determining factor which a prospective rotary furnace user can go by in selecting the proper size of furnace for his particular forging job. A 20 ft diameter rotary furnace, which is rated by some manufacturers at 8000 lb per hr, is rated by other manufacturers at 12,000 lb per hr.

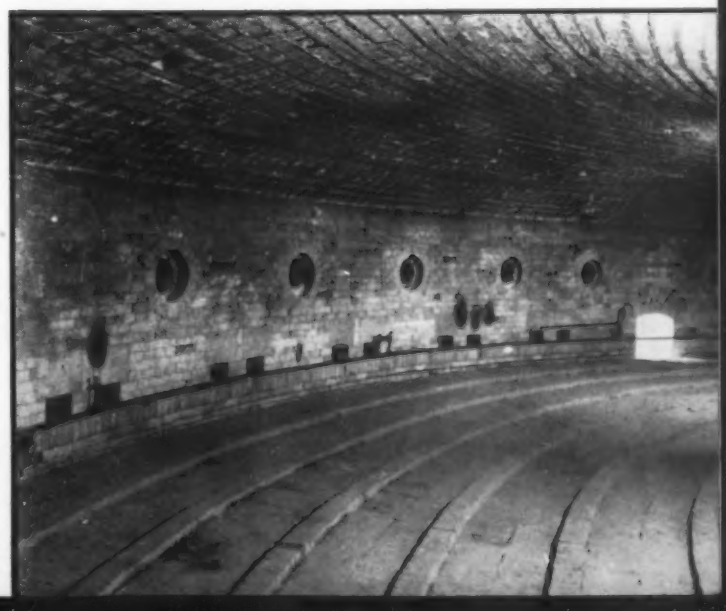
There is no question but that the 20 ft unit will do 12,000 lb per hr. Under emergency conditions, this size furnace has actually produced 16,000 lb in one hour but it must be realized that there is an economical limit to the production rate

A number of rotary hearth furnace builders have clung to the flanged wheel principle for maintaining the revolving hearth in position. This has not been found wholly satisfactory. In one plant where this method is used, the maintenance crew is so familiar with what generally happens that when they are called upon to service the rotary furnace they automatically bring along several jacks. They are certain the hearth has jumped its track.

A more satisfactory arrangement has been to use a center bearing which serves as a pivot for the entire hearth and allows the hearth to expand in all directions. When this is done, flanges are not required on the wheels.

Figure 6 — Combination oil or gas burners installed on ← large rotary furnace serving a piercing mill.

Figure 7 — Inside view of rotary furnace rated at 40 tons per hr. Note piers on hearth.



The standard drive for units of this type is the rack-and-pinion type. A cast iron rack fastened to the underside of the rotating hearth is engaged by a motor driven pinion. This drive is positive and in most cases has proved satisfactory.

Another accepted type of drive is the chain type. This consists of a heavy chain with special link attachments bolting it to the outer shell of the hearth. This chain serves as a rack. A vertical pinion or a caterpillar type drive section engages this chain rack. The pinion or caterpillar drive section is generally designed so that it can shift in or out as the rotating hearth moves or expands.

Some of the older rotary hearth furnaces were driven by means of a pusher rod or pawl type mechanism. This was operated from a motor driven cam or crank. This drive often became jerky and required considerable maintenance. In later years, however, hydraulically operated drives have been used with much success. These are especially desirable where it is necessary to index the hearth a predetermined number of degrees.

The location of burners is one of the most important features of a rotary furnace. If the centerline of the burners is kept at least 18 in. above the top of the billets, there is very little chance of overheating. If the centerline is much closer than 18 in., the top end of each billet is likely to be washed while the end on the hearth remains comparatively cold.

Burners placed too close to the furnace roof or dome can also produce very serious results. This is especially true when firing with oil. There have been cases where oil burners placed too close to the roof collected carbon in the port and deflected the flame upward causing the flame to burn completely through the refractory dome. To eliminate this possibility, the burners in properly designed furnaces are ordinarily kept at least 12 in. below the spring line of the dome.

But regardless of all the rules governing proper furnace design, there is always the exception. One exception is a plant that purposely operates its rotary forging furnaces so that the top end of the billet is overheated and the bottom end kept relatively cold.

This plant is piercing large high-explosive shells and in the particular method of piercing used, it has been found necessary to keep the top end of the billet hot for easy piercing and to keep the bottom end cold to maintain the end wall thickness. In most shell making processes this is not true but in this particular case a properly designed furnace that heats uniformly would not give the desired results.

The most important features to consider when selecting a rotary hearth furnace for heating prior to forging are basic engineering details of construction which each engineering department must decide in its own way: Location of burners as related to the steel or the furnace dome, and the size of the furnace. If, as explained before, the size of the furnace is such as to cause excessive maintenance, the furnace will be too expensive to operate. A figure of 40 lb per hr per sq ft of hearth is a very safe figure to consider when determining whether or not the furnace is of the proper size. If the billets to be heated can be placed on end, this 40 lb figure may be increased. As this figure is increased to the point where an excessive temperature head must be carried in the furnace, the unit becomes more and more expensive to operate. This is due to rapidly increasing maintenance costs and decreased thermal efficiency.

It is hoped that more definite rules governing heating rates for various shaped pieces and methods of loading will soon be available. At present, however, these rules-of-thumb are the best methods suggested for checking furnace size.

For as many years as piercing mills have been in existence, sloping hearth roll-down furnaces have been feeding hot billets to these mills. Undoubtedly, the roll-down furnace was originally selected for this job

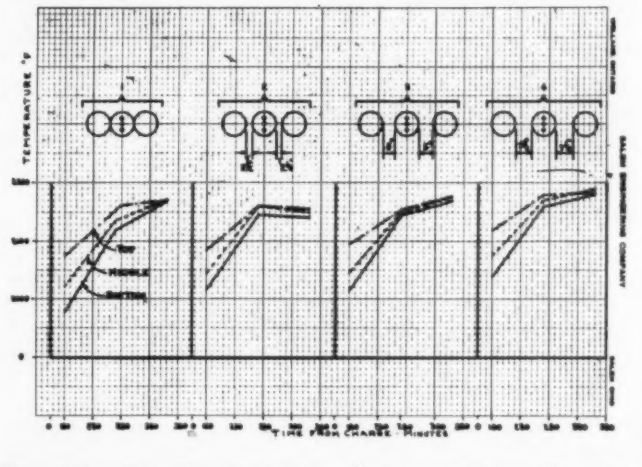


Figure 8 — Results of heating tests on 10 in. diameter billets with various spacing.

because it seemed to provide the most inexpensive means for conveying the billets from the cold end of a furnace to the hot end. After such a furnace has been in operation several days, there is a large accumulation of scale on the hearth. This scale, along with other refractory obstructions formed by wear, prevents the billets from rolling without assistance.

One of the most unpleasant tasks in any steel mill is done by the men who manipulate these billets down the sloping furnace hearth. The usual procedure is to block one group of billets near the charging end and another group further down the hearth. When the blocks are removed the billets roll forward. If they do not roll the operators must use heavy bars and special tools to force them into position. All of this work is done through small manipulating doors staggered along both sides of the furnace. The pressure developed at points inside the furnace is so great that a considerable amount of heat is forced out of these manipulating doors and into the faces of the furnace operators. There is no question but that this is one of the hottest jobs a man can have. A large number of spell men are necessary in addition to the regular furnace operators.

When the billet rolls into the discharge trough at the hot end of the furnace, it is pushed out through a side door by means of an automatic ram. As soon as the ram returns to its back position, another billet either rolls or is manipulated manually into the discharge trough.

About three years ago, one of the most progressive steel companies in this country conceived the idea that their roll-down piercing mill furnace could be improved

from a labor standpoint, as well as from a standpoint of surface scale and quality heating. When the problem was presented to the furnace engineers it was agreed that an entirely different type of furnace should be employed.

The production was estimated to be 15 tons of round billets per hour when heating from cold to 2250 F. Billet diameters ranged from 2¾ in. up to 4½ in. and billet lengths were not to exceed 5 ft 6 in.

In selecting the type of furnace, three major factors were considered. The new furnace would have to develop less scale; it would have to improve the quality of heating; and it had to eliminate positively the bad working conditions and excessive labor expense. A rotary furnace was finally selected for the job. It was quite evident that there would be less scale in the rotary furnace than in a roll-down because the billets would not roll. In the roll-down furnace, every time a billet revolves, it breaks off part or all of its scale jacket and then promptly forms a new jacket. In the rotary furnace where the billets remain stationary, only one scale jacket can be formed.

The quality of heating was certain to improve in the rotary furnace because there were no openings required around the rotating hearth for manipulation of the billets. The elimination of these doors would allow the rotary furnace to operate under pressure with the burners set at the exact desired ratio to maintain an atmosphere that would produce the best surface condition on the steel billets.

It was obvious that the rotary furnace would require less operating labor than the roll-down furnace. By incorporating an automatic charging and discharging mechanism, it was realized that one man would be able to load and unload the furnace without assistance.

As soon as these economies were presented to the management of the company, instructions were issued to build a rotary hearth furnace as rapidly as possible. The results were so highly satisfactory that immediate consideration was given to installing a similar rotary on one of the company's larger mills. The production on this larger mill was estimated at 40 tons per hour when operating on high carbon steels. The maximum temperature was not to exceed 2350 F and the burners were to utilize either gas or oil.

The billets to be pierced on this large mill ranged up to 10 in. in diameter with a maximum length of 14 ft. The 10 in. diameter billet presented several problems. The most important question was: Would it heat uniformly enough from top to bottom to make a concentric pierce? In order to answer this question a rather extensive test was run on the 15-ton rotary with 10 in. diameter billets. It was further realized that the spacing of the billets might have considerable effect on their uniformity of heating. The test was run, therefore, using four different spacings: 10 in., 12½ in., 15 in. and 17½ in. This spacing was measured on the inside radius of the billet circle. Temperature checks were taken on top of the billets in the center and at the bottom.

Although these results indicated that the billets actually could touch one another and still be heated uniformly, it was thought advisable to space them several inches apart so as not to complicate the loading and unloading mechanisms. The tongs required for picking up these heavy billets had to be made thick and of heavy construction. It was necessary, therefore, to keep the billets apart to provide clearance for the tongs rather than to insure uniform heating.

During this test the scale loss on these billets was found to be exceedingly low, averaging 0.48 per cent of the total weight of the billets charged.

The new 40-ton furnace was designed with a centerline diameter on the rotating doughnut hearth of 52 ft 6 in. The rotating hearth itself was 15 ft 6 in. wide with an effective loading width of 14 ft. The resultant overall diameter of the furnace proper was 75 ft.

The billets are handled into the furnace automatically and no operator is required. The discharging mechanism, however, does require an operator. This is the only handling labor required for the entire furnace.

After operating this large furnace for almost two years, one of the steel company's engineers wrote as follows:

"We feel that these furnaces are a distinct improve-

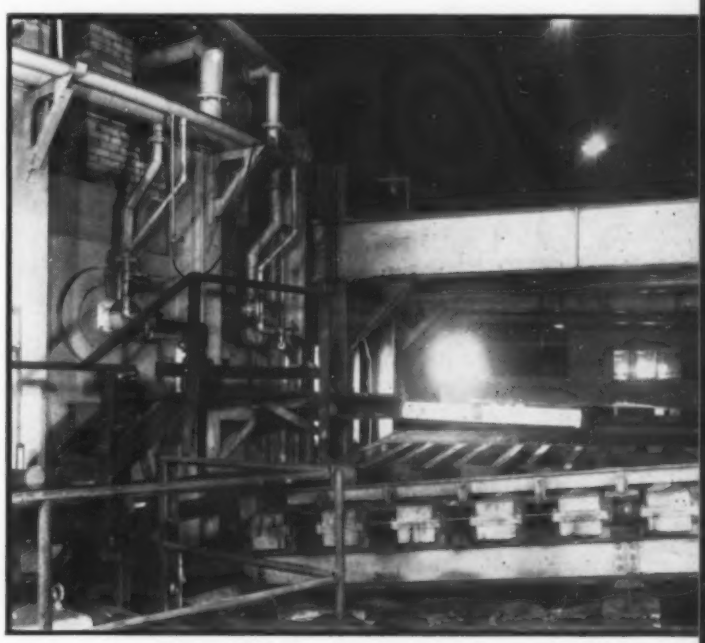


Figure 9 — Discharging mechanism removing hot billet from a rotary furnace.

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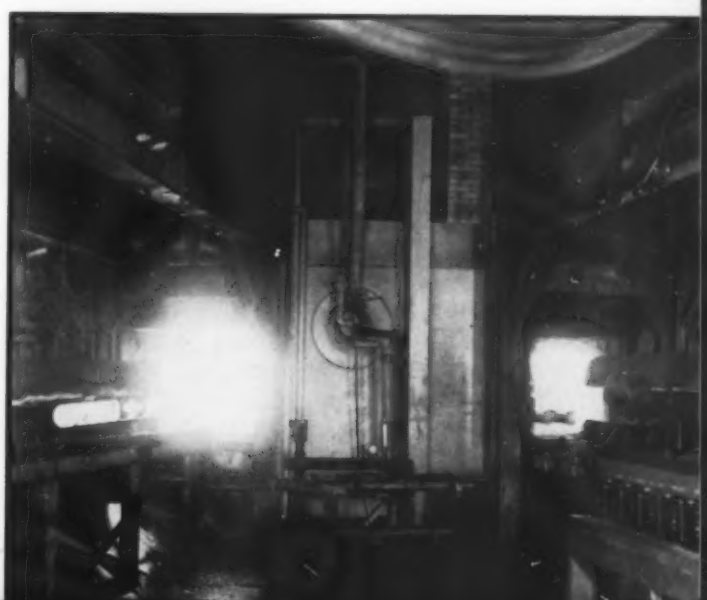
Figure 10 — Charger and discharger units operate side by side through two doors in this large rotary furnace.



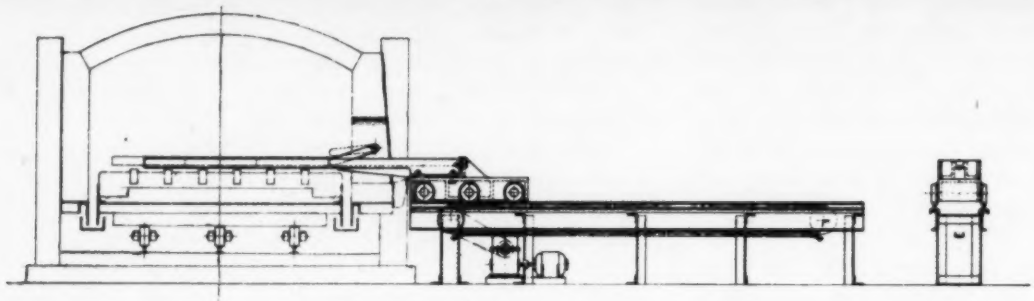


Figure 11 — Sketch showing arrangement of automatic charger for billets.

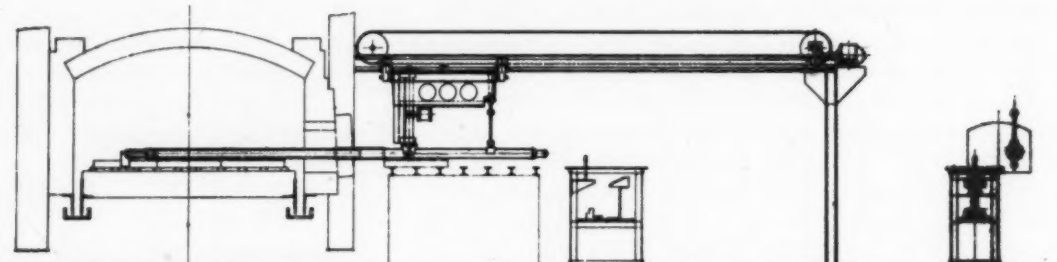


Figure 12 — Sketch showing discharger for billets, operated by remote control.

ment over the older sloping hearth roll-down furnaces which required considerable labor. In comparison with previous furnaces, we find the rotary hearth furnaces are showing a saving of approximately 2 per cent in scale loss, which is the greatest economy effected by this design of furnace.

"The second item is a question of manpower. This type of furnace results in a saving in our case of six men per turn. No fuel economy is apparent as compared with the older furnaces."

When operating the furnace at a production rate of 40 tons per hour, 500 hours per month, the scale loss saving of 2 per cent amounts to 400 tons a month. At $50.00 a ton, this totals $20,000 a month. Six men per turn at $1.00 an hour totals approximately $3000 a month. The total saving is then $23,000 a month or $276,000 per year. Such an item is of considerable interest to any seamless tube manufacturer.

The principal reason that no fuel economy has been apparent on these rotary piercing mill furnaces is that many of the older roll-down furnaces utilized recuperators, whereas the rotary units do not. In addition to this, it must be realized that more hearth area is provided in the rotary furnace because the billets cannot be spaced one against the other. This means more area in walls and roof, and hence more radiation loss.

One of the most interesting features provided on this 40-ton furnace is the spacing loading disc. This disc is about 6 ft in diameter and made of black metal. The frame surrounding the disc is marked off to represent the stationary part of the furnace, divided into five zones of control just as the furnace is divided. When a new batch of material is charged into the furnace, a mark is made on this loading disc. As the furnace revolves the disc also revolves, indicating just where the charge is in relation to the furnace travel. When a number of small heats are put into the furnace, it is very easy by referring to this loading disc to calculate when a heat will be finished. This loading disc is geared direct to the furnace drive and therefore can not get out of synchronism with the hearth travel.

For a piercing mill that can produce between 200 and 300 pieces per hour, particular attention must be given to the charging and discharging mechanisms. The charging mechanism consists of a long peel formed into the shape of a trough. Billets are automatically kicked into this peel trough when it is in the "out" position. A contact, indexed with the furnace drive, starts the loaded peel into the furnace. A water-cooled prong, hinged to the furnace proper, drags over the top of the billet and drops behind it when the peel trough is all the way in the furnace. As the charger is withdrawn the water-cooled prong blocks the billet so that it is skidded off the trough and brought to rest on the furnace hearth. Several lengths of short billets can be handled in this type of charger just as well as one long billet.

To discharge billets from a furnace at a rate of 300 pieces per hour, the discharging mechanism must be designed so that the operator has a minimum number of control levers. Such a unit is now being put into operation on a mill that produces regularly 240 pierced tubes per hour.

The peel on this discharging mechanism is equipped with regular tong clamps, air operated. The two special features are that the peel can be moved in all directions much as an anti-aircraft gun, and that remote controls are used throughout so that the operator may be placed in a stationary cage. If the operator were required to ride the unit, stopping and starting as frequently as it does, the job would become very objectionable.

The control cage is placed where the operator can see directly into the furnace discharge door. The operator is comfortably seated with his right foot resting on a reversing master switch which controls the travel of the discharger into and out of the furnace, and his left foot resting on an air valve which controls the tong clamps on the end of the peel. Directly in front of the operator there is the peel control stick. This control stick may be moved forward or sidewise. It is spring-loaded so that if released, it will return to the neutral position. Linked to the lower end of this control stick

are two transmitting selsyns. Forward or backward movement of the stick reacts on one selsyn and sidewise motion of the lever reacts on the other. These units are electrically interlocked with two receiving selsyns mounted on the moving framework of the discharging machine. These selsyns control the valving of the hydraulic equipment that moves the discharging peel in two planes.

As a result, all the operator has to do to pick up a billet is to start the machine into the furnace by means of the foot-operated master switch; swing the peel into position with the control lever; and then kick on the air control valve when the tongs have reached the proper position above the billet. With the billet clamped securely, the operator pulls the peel control lever all the way back, lifting the billet off the hearth, and then reverses the foot-operated master switch causing the mechanism to move rapidly out of the furnace. When the hot billet is directly over the skid rails leading to the piercing mill, the billet may be dropped automatically by means of a limit switch, or released by the operator.

It is not the intention of this paper to claim that the rotary hearth furnace is the answer to all furnace problems. Rotaries have become amazingly popular in recent years, yet most of the applications that were made could have been made years ago. The first piercing mill, for example, could have been equipped with a rotary furnace just as well as with a sloping hearth furnace.

The years have brought improvements in design, of course. The rotary has many advantages: It can be loaded and unloaded from one spot; it can maintain a proper atmosphere and pressure; and it is inherently self-emptying. These are outstanding features worthy of real consideration, but it is the simplicity of the rotary — simplicity of design and simplicity of operation — that has been responsible for its success.

DISCUSSION

PRESENTED BY

J. J. ALEXANDER, Assistant Power Superintendent, Republic Steel Corporation, Cleveland, Ohio

J. H. LOUX, Salem Engineering Company, Salem, Ohio

E. E. CALLINAN, Combustion and Refractory Engineer, Steel and Tube Division, Timken Roller Bearing Company, Canton, Ohio

A. J. FISHER, Fuel Engineer, Bethlehem Steel Company, Sparrows Point, Maryland

***R. I. GUMAER, Fuel Engineer, Jones and Laughlin Steel Corporation, Aliquippa, Pennsylvania**

C. E. HAGUE, District Representative, Askania Regulator Company, Cleveland, Ohio

C. T. SCHORR, Fuel and Power Engineer, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania

R. L. WILLIS, Superintendent of Combustion, Bethlehem Steel Company, Bethlehem, Pennsylvania

A. D. DAUCH, Vice-President, Geo. J. Hagan Company, Pittsburgh, Pennsylvania

***Deceased**

J. J. Alexander: I believe Mr. Loux stated that there was no saving in fuel compared to the older type of roll-down furnace. Have recuperators been employed at all on the rotary hearth furnaces?

J. H. Loux: They have not been used to any great extent that we know of, mainly because of the additional installation expense involved. It is very difficult to collect all of the gases from a big rotary furnace, much more difficult than it is from a standard roll-down, but it can be done.

I am not familiar with any case where such recuperators have been installed and put in operation in this country. We have built rotary forging furnaces equipped with recuperators for export.

E. E. Callinan: Answering the question on fuel consumption, it no doubt will depend upon which of the various types, such as Mr. Loux described, is being considered and also upon operating conditions, type product and type of steel.

On the large piercing mill rotary furnace, as we see it, the greatest advantages are decreased manpower, more uniform and controlled heating, a definite decrease in scale loss, and ability to set up and to duplicate more precise heating cycles. The latter is quite important in our case since we are dealing with many different types of steel, ranging from as high as 1.50 carbon down to the more common grades, and with high and low alloy contents.

Another feature which we like is that this furnace has five zones of burner control as against the three-zone control in the sloping hearth furnace which it replaced. This gives much greater flexibility in setting and controlling heating cycles, particularly when there is a wide variety of types and sizes of billets.

Answering the question on fuel consumption, even before the furnace was built we did not anticipate any appreciable savings in fuel costs. This is due to several factors. One is that the nature of our orders is such that our average delay time, due to mill size changes, etc., is somewhat over 50 per cent. Another factor, we feel, is the fact that this rotary furnace, as compared to the sloping hearth furnace which it replaced, has a much larger surface area, considering roof, sidewalls and hearth, through which heat losses occur.

Still a third factor is that the furnace is cross fired so the length of flame travel is only about 16 feet, a multiplicity of outlet flues being located in both the inside and outside walls. In the old sloping hearth furnace the combustion products from the soaking zone burners had to travel 90 ft to the outlet flue and the outlet flue gas temperature naturally was lower than the average outlet temperature of the rotary hearth unit.

But in spite of the fact that we do not obtain a fuel savings, it should be remembered that the savings in scale loss alone, or manpower or increased quality alone, results in a more economical operation. I believe if we were running large orders on which it was not necessary to make such drastic changes in temperatures at the exit and entrance zones, we could adjust our outlet flues differently so that together with a reduction in delay time some fuel savings could be realized. To date, costs have amply justified the installation of this furnace.

I might add a few more details about the large furnace mentioned in the paper. It is 76 ft in diameter, 69 ft in diameter from the inside of the outer wall. The hearth is 15 ft 6 in. wide and has an effective length of 212 ft measured on the outside diameter of the hearth. The hearth is driven by a 7½ hp motor but uses only about half that amount in actual horsepower input. The maximum hearth speed is 1 hr 20 min from charge to discharge door. This speed is variable and can be reduced to about 6 hours. The furnace is equipped with temperature controls, fuel-air ratio control and combination oil-natural gas burners.

A. J. Fisher: What was the Btu rate for the rotary furnace in question?

E. E. Callinan: On a 6 day week basis, we find that it varies depending upon sizes of billets and individual orders, from 2,600,000 Btu up to 3,000,000 Btu per ton. This is not a low figure but is about the same as obtained on the furnace which was replaced.

R. I. Gumaer: In heating the short blanks for shell forgings, I would like to ask Mr. Loux what is considered the practical ratio of diameter to height for carrying the billets on end? If a billet is, say, 4 in. in diameter, how tall a billet would you say could be carried without danger of upsetting?

J. H. Loux: Generally speaking, we consider a billet to be in no danger of upsetting if the height is double the diameter. You can carry them higher, but to be safe that is what we prefer.

C. E. Hague: Our interest in these furnaces has been in the control of combustion in the larger units and the reduction of scale formation, the object of our effort.

Although the firing chambers in these furnaces are continuous circular spaces, with no division walls or cross arches, they are remarkably controllable in zones. This is due, I believe, to two inherent features of furnace design. First, the action of the burners is directly across the hearth, producing no tendency to tangential movement of the gases along the hearth. Second, the furnaces are vented at numerous places around the circumference, the vent openings being located at the hearth line and leading into individual vent stacks that extend upward only to the approximate level of the roof crown, producing a condition of balance with regard to draft. These two features of design, coupled with an efficient seal and the absence of doors, produces a condition of localized turbulence that is ideal for zone control.

Two other features of the furnace design contribute in large measure to the remarkably low rate of scale formation. The billets are charged and discharged through adjacent doors and are undisturbed through the entire heating cycle. They are not moved or jostled and the first scale that forms remains as a protection against further scaling. Also the charging and discharging mechanisms lay the billets down onto the hearth and pick them up instead of sliding them and a very minimum of scale is deposited on the hearth. The hearths remain clean and are subjected to a minimum of abuse.

A hypothetical evaluation of a 2 per cent scale saving makes interesting reading. Assuming a production rate of 40 tons per hour, 500 hours per month, of high carbon steel worth $50.00 per ton, the saving is $20,000.00 per month.

Then assume that 2,000,000 Btu is required to heat each ton of steel and that the fuel is natural gas costing $.35 per thousand cubic feet. The total monthly fuel cost would be about $14,000.00, or only about two-thirds of the amount saved by reducing the scale by 2 per cent.

It would seem that unless these furnaces are possessed of drawbacks which have not been brought out, they should become popular for many applications.

I would like to ask Mr. Loux these questions:

1. Do the hearths of these furnaces remain circular and concentric with the stationary parts, or does expansion cause misalignment of seals, driving mechanism, under carriage and trackway?
2. How much power is required to drive the rotating hearth of the seventy-five foot furnace described in the paper?
3. What has been the record of maintenance cost of the furnace roof, walls and hearth, and what material is used in the hearth?
4. Do these furnaces need to be installed in especially designed buildings? Do the waste gases produce unfavorable working conditions within the buildings where they are located?

J. H. Loux: This large circular hearth is made with several special features. In fact, the bottom structure of the hearth is made in two separate frames. The framework supporting the wheels is not fastened in any way to the framework supporting the refractory hearth, and the steel of the refractory hearth can shift within certain limits without causing any distortion whatsoever in the framework that carries the wheels. Then, in addition to that, there are spring-loaded rollers on the inside diameter which keep the hearth centered, and we believe it is the combination of these two features that maintains the hearth in a circle.

As Mr. Callinan said, there is a 7½ horsepower motor on this furnace and we understand it operates at about half capacity with the hearth revolving at the fastest rate. The roof and walls of the furnace are made of first quality fire brick.

As far as ventilation is concerned, it is warm around the furnace but no more so than around any other. Based on what has been done, we would say that the roof ventilation space should be about 20 square feet of area for every ton of steel heated per hour.

E. E. Callinan: Speaking of refractory maintenance I might add that to date no maintenance has been required on the side walls or roof. The furnace has been in operation more than a year and a half. The last time it was inspected it had taken a nice glaze and looked even better than when originally constructed.

We have once replaced the piers on the car. We think their deterioration was due to considerable extent to the fact that, as originally built, the charging peel was cooled by water spray at such a time that it dripped water as it entered the furnace. This has been corrected and we expect to obtain longer life on the present installation.

There is not much scale deposit, and what is there is a dry scale, so we anticipate a lengthy hearth life.

C. T. Schorr: I would like to ask Mr. Loux how this furnace lends itself to flexibility. Can he change his flame length and the hearth length in the large rotary

furnace to heat smaller diameter bars and things like that?

J. H. Loux: There is that problem. When heating short length bars, it is necessary to load them several lengths deep. I tried to point out that on this charging mechanism you can load more than one bar in the trough-type peel. Therefore you can have several rows, If your rolling lengths are so short that you have to have three rows then your mill will be the determining factor of the speed of operation.

In other words, your furnace will be capable of heating more billets per hour than the mill can roll. The thing to do in that case would be to shut off the first zone or just have the burner set very low and always charge three rows so that you have a furnace full of steel at all times but are heating only in maybe the last two-thirds of the furnace. The two-thirds of the furnace would easily keep up with the mill on those short sizes.

E. E. Callinan: I might add that the spacing of the billets and the speed of the hearth can be so integrated as to produce optimum heating cycles. These are important factors in setting the furnace speed of production to meet the mill production capacity.

The spacing of the billets can be adjusted over quite a range, and when set will automatically maintain that spacing regardless of hearth speed changes, because the device which controls the billet spacing is geared up to the hearth so that if hearth speed is changed the billets are charged at longer or shorter time intervals but with the same spacing on the hearth.

R. L. Willis: The difficulty of selecting the proper size rotary furnace for any particular job was well stated by Mr. Loux. It is indeed unfortunate that a 20-ft rotary furnace is rated by various manufacturers anywhere from 8000 to 12,000 lb per hr.

One of the greatest difficulties encountered in the selection of rotary hearth furnaces from the heating standpoint is the tendency to be too optimistic in the rate of heating desired. The result is that the forging unit cannot handle the steel at that rate except for short periods of time. As a consequence, the steel is held at temperature for rather long intervals — longer than desirable — with resultant heavy scale. Quite frequently overheating is encountered as well, due to the inability of the burners and controls to cut back far enough under this slower heating rate.

Too frequently the manufacturer of the furnace is given a monthly production based on 500 or 600 operating hours. The difficulty is that in actual practice the operation does not continue for 500 or 600 continuous hours and then shut down the rest of the month, but it is more nearly continuous throughout the month, with one or two hours' delay on every eight-hour shift. This means that the average production rate is actually met only a few hours every shift, with excessive scale and overheating the rest of the time.

The steel manufacturer must be more conservative, or at least less optimistic, in anticipating the forging and heating rate upon which the furnace manufacturer bases his design. This condition would apply to any type furnace, not just rotary furnaces. It is an important factor in the design or purchase of any furnace, the tendency being to be sure to have an excessive heating capacity.

Our experience with rotary furnaces has been very satisfactory. The original roof is still on the first one installed, which was about three years ago. We feel that temperatures should not exceed approximately 2350 F due to slagging on the hearth.

A comment with regard to the standing of billets on end: We forge from 4-5 in. square billets up to 14 inches in length standing on end. They are not always perfectly squared off, but with reasonably careful handling we have encountered no difficulty in preventing them from falling down.

A. D. Dauch: I think more will be heard about rotary furnaces, particularly as the postwar program develops. I can tell you this: In the forging industry, making shells, airplane engine forgings, and various forgings for tanks, etc., we alone have applied over 200 of the rotary forging furnace units.

I think Mr. Willis is correct as regards the ratio of billet length to width. The multiplier is about three.

R. I. Gumaer: It would be interesting if Mr. Loux could enlarge a little on the baffle that is suspended in the furnace, apparently between the charging and discharge doors. Is that a necessary item in these furnaces?

J. H. Loux: That is right. Wherever there are two doors provided, we always install a suspended baffle because it does help considerably to prevent black body radiation from the hot steel to the cold steel, and if you have to stop the furnace for adjustments on the forging machine, there is much less tendency for the hot steel to lose heat.

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THE *Rectifier Installation* AT ALAN WOOD STEEL COMPANY

. . . . operating experience on the rectifier installation made in accordance with the survey in the author's paper of two years ago has shown greatly improved operating efficiency and a high degree of reliability with little maintenance . . . .

by A. D. Howry

PLANT ELECTRICAL ENGINEER
ALAN WOOD STEEL COMPANY
CONSHOHOCKEN, PENNSYLVANIA

▲ TWO years ago, the author presented a paper before the Association of Iron and Steel Engineers in Philadelphia, Pennsylvania, entitled "The Application of Mercury Arc Rectifiers in Steel Mills" (Iron and Steel Engineer, August, 1943). That paper was basically part of the recommendation and justification for the proposed installation of rectifiers at the Ivy Rock plant of the Alan Wood Steel Company. Today this equipment is installed and operating, and has been well justified by subsequent performance. This paper therefore is descriptive of the installation and the results obtained.

The previous system consisted of two 1000 kw synchronous motor generator sets, and three 300 kw engine type generators, all rated 230 volt d-c; the motor generator sets operated on 2300 volt, 3-phase, 25 cycles from our generating plant at Swedeland, while the engine generators obtained steam from an adjacent boiler house. Normal operation was on the two 1000 kw motor generator sets with the engine generators as standby. Distribution was from this centrally located installation to the various points of utilization, with the greatest demand area being the farthest from point of generation.

We all appreciate that a condition such as this is the natural result of years of growth. When the station was originally built the logical location for the three 300 kw engine generators was adjacent to the boiler house furnishing steam to the blooming mill reversing engine, and as the loads were relatively light no problem of distribution was encountered. Later, during World War I when the d-c requirements demanded additional generating capacity, it was logical that the location selected for the two 1000 kw synchronous motor generator sets should be in the same building, as all units would be under the supervision of one operating force.

Upon the installation of the motor generator sets the three engine generators were held for standby use. Later it became necessary to operate one of the engine generators in addition to the motor generator sets to provide for increased demands due to war activities. This comprised the 230 volt d-c system of the steel works; the load, as in all steel plants, fluctuated considerably with peaks as high as 150 per cent of the capacity of the two motor generator sets.

As production increased it became apparent that additional capacity must be installed to provide for the increased demands. The problem which confronted us was complicated, as the d-c system mentioned was a part of the complete generation and distribution system for the entire plant. This system consists of two 2300 volt, 3-phase, 25 cycle turbogenerators, one rated at 5000 kva and one at 6250 kva, at 80 per cent power factor, furnishing power to the Schuylkill Iron Works division, the Rainey-Wood Coke division, the blast furnace division and the steel works division. The additional capacity required could either be furnished by the installation of a new turbo-generator or the introduction of purchased power. In either case the prob-

Presented before A. I. S. E. Philadelphia District Section Meeting, January 5, 1945.

lem of application was critical, as the present 2300 volt, 25 cycle system was already at its maximum safe capacity of 10,000 kva.

The final decision to convert the steel works to 60 cycle operation directly on purchased power was the result of extensive studies, based on economies, future expansion and equipment coordination. The studies involved in this decision are complex and are irrevelant to this discussion, except that they formed the basis of replacement of the two motor generator sets.

The decision to purchase mercury arc rectifiers, automatically operated and remotely controlled, was based on findings as outlined in the earlier paper mentioned previously. The recommendations approved and installed were as follows:

1. Replace the two 1000 kw, 2300 volt, 3-phase, 25 cycle motor generator sets with two 1000 kw, 6900 volt, 3-phase, 60 cycle mercury arc rectifiers.
2. Install one rectifier in the new powerhouse adjacent to the old location of the motor generator sets.
3. Install one rectifier at the center of load in the open hearth.
4. Install new 250 volt d-c feeder switchgear units of the automatic reclosing type.
5. Convert all continuous load equipment such as air compressors, river pumps, and lights to 60 cycle a-c operation.

The recommendation to replace the two 1000 kw motor generator sets, which were definitely overloaded, with two 1000 kw mercury arc rectifiers was based on the following factors:

1. Reduction of load due to conversions of minor equipment from d-c to a-c operation.
2. Reduction of load due to reduction of 250 volt d-c line drop loss.
3. Availability of overload capacity inherent to the mercury arc rectifiers.

The specifications called for two multi-tank type mercury arc rectifiers, rated 1000 kw, 4000 amp at 250 volt d-c continuous, 1250 kw, 5000 amp at 250 d-c for two hours, and 2000 kw, 8000 amp at 250 volt d-c for one minute. These units are complete with transformers, control cubicles, d-c voltage regulation and d-c rectifier breaker switchgear, and are equipped for automatic operation by remote control from the centrally located a-c switchgear. The transformers are six-phase with 6600 volt, 3 phase, 60 cycle primary. The Ivy Rock unit is oil-less type for indoor installation, with the primary connected in delta, while the open hearth unit is of the oil insulated, air cooled type for outdoor vault installation, with the primary connected in wye. The delta and wye connections of the transformers give us the effect of a single 12-phase unit on the a-c system, thus minimizing interference due to rectifier harmonics.

The rectifiers purchased were twelve-tank units complete with transformers, control cubicles, auxiliaries and d-c breakers, which were specified so as to line up and be part of the complete d-c distribution switchgear. The a-c breakers, remotely located, are a part of the complete 6900 volt distribution and control switchgear. With this equipment coming from three different manufacturers to form a complete operating unit, close coordination of engineering and installation was required, and the successful operation of the completed project speaks for the close cooperation extended us.

The installation arrangement consists of both rectifier a-c breakers installed as units of the main 6900 volt a-c switchgear (Figure 1). These units are of the metal-clad draw-out type air circuit breaker, rated at 1200 amp, 15 kv. The panels are equipped with ammeter,

Figure 1 — Rectifier a-c breakers are installed as units of the main 6900 volt a-c switchgear.

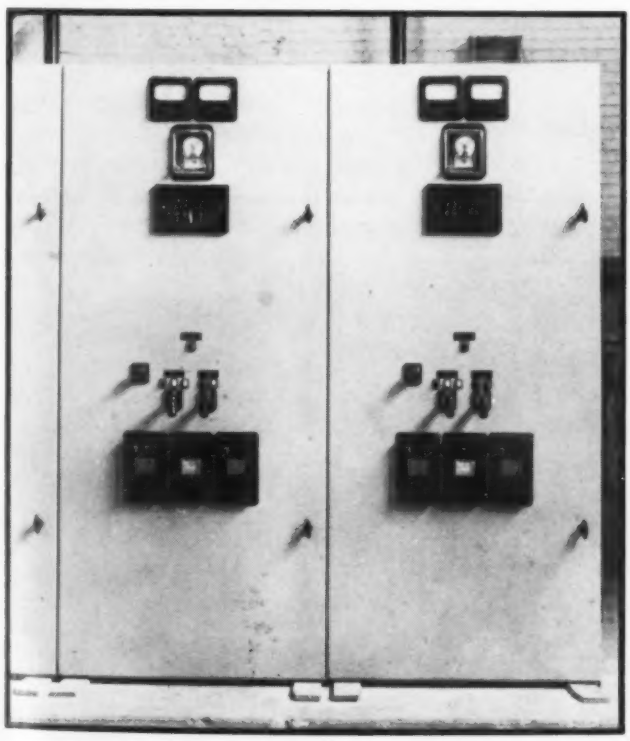
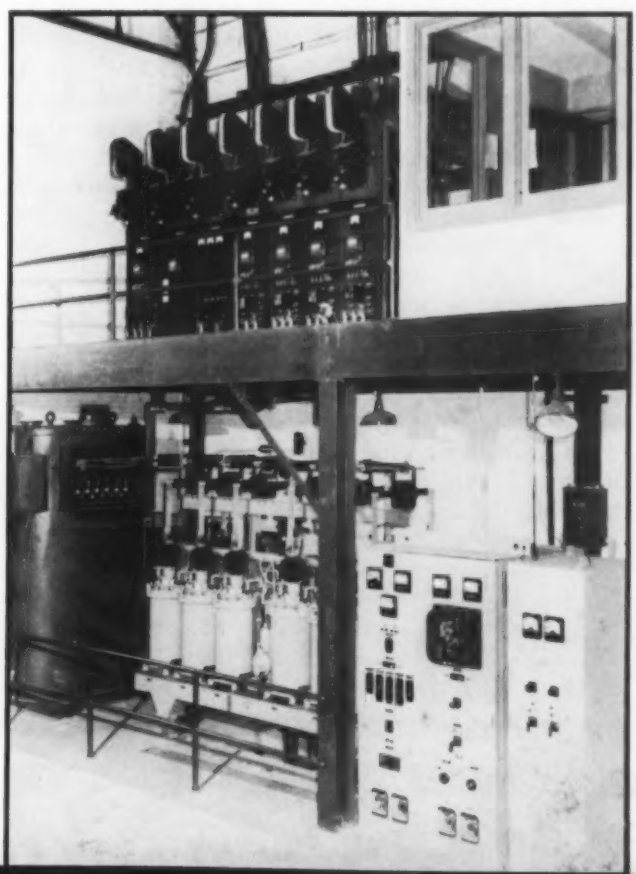


Figure 2 — View of Ivy Rock rectifier installation, with oil-less transformer immediately adjacent.



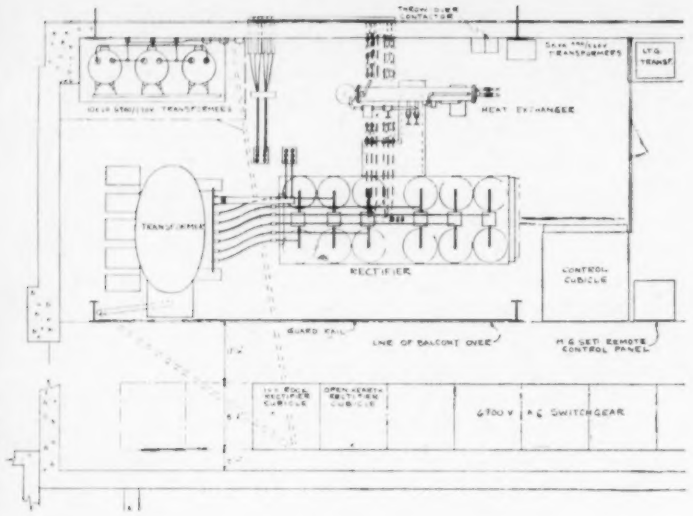


Figure 3 — Plan drawing of Ivy Rock rectifier installation.

wattmeter, watthour-meter with demand attachment, overload relays and phase balance relay. Control for remote operation is by two control switches, one for rectifier auxiliary equipment control and the other for closing the a-c breaker.

The Ivy Rock rectifier (Figure 2) is installed in the same building as the a-c switchgear, and is connected by a three-conductor cable direct to the indoor type, chlorextol-filled rectifier power transformer, the six-phase secondary being connected directly to the rectifier anodes by twelve 1,000,000 cir mils overhead cables. The rectifier control cubicle is placed at the opposite end of the rectifier, with the water-to-water heat exchanger being placed in the rear. The rectifier d-c circuit breakers are placed on the balcony directly over the rectifier and form a part of the 250 volt d-c distribution switchgear.

The open hearth rectifier (Figure 4) is installed in a separate building near the center of load in the open hearth, being connected by 1800 ft of overhead line consisting of three 2/0 bare cables. This line terminates in a pothead with cable connections to a cable isolator built into the outdoor oil-insulated rectifier transformer. This installation differs from the Ivy Rock installation in that the transformer is located outdoors in a vault, being separated from the rectifier by a brick wall; otherwise the arrangement is the same.

The location of this substation presented difficult problems of construction due to the congestion of the area. The site selected required that provisions be made for a scale house, lavatory, and ladies' rest room. This site is shown in Figure 5 with the completed building shown in Figure 6. All the facilities mentioned are incorporated in the new building, which is equipped with filtered tempered air circulation.

The general arrangement of equipment is shown by the plan view (Figure 7) and elevation (Figure 8), and the 250 volt d-c switchgear plan is indicated in Figure 9.

Each rectifier control cubicle (Figure 10) is arranged for local manual or remote automatic operation; for remote operation all controls are set on automatic. The regulator is adjusted to the voltage value required by rheostat control, and the rectifier d-c breaker control switch is moved to the closed position.

To place the rectifier on the line the remote master control switch on the a-c switchgear cubicle is closed. This closes the ignition and excitation circuits of the rectifier, which is indicated by an amber light at the master control switch. Upon light indication, the a-c breaker is closed by the adjacent control switch, energizing the rectifier transformer and rectifier. The d-c output of the rectifier then closes the rectifier d-c breakers, the closing of which is indicated by the red light at the master control switch, while load is indicated by the ammeter and wattmeter.

As auxiliary power at 220 volt, 3-phase, 60 cycle is required for operation of the excitation, ignition, regulator grid bias control, vacuum pump, water pump and heaters, a bank of three 10 kva, 6600/220 volt transformers are provided for operation when the rectifier is in service. As this auxiliary transformer bank obtains power from the rectifier transformer feeder cable, a

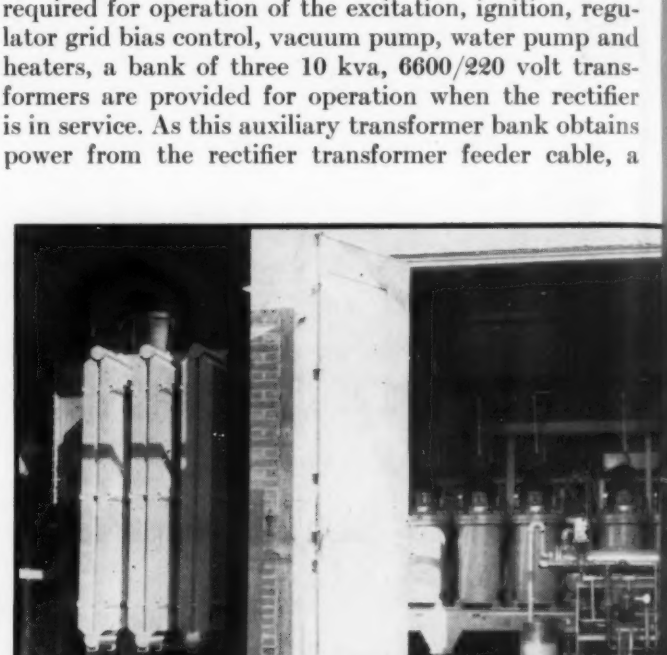
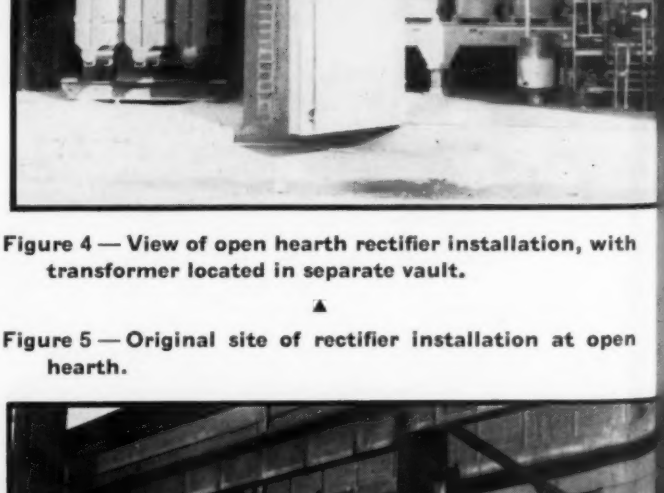


Figure 4 — View of open hearth rectifier installation, with transformer located in separate vault.

▲

Figure 5 — Original site of rectifier installation at open hearth.



supplementary bank of three 5 kva transformers was installed for operation of the vacuum pump, water pump and heaters when the rectifier is deenergized. This bank obtains power from the local 440 volt shop circuit and is controlled automatically by throw-over contactors upon energizing of the rectifier. All control, indication and alarm is actuated by a 13-conductor lead-covered cable connecting the rectifier cubicle and the a-c control panel.

The 250 volt d-c distribution system shows a radical departure from the old system shown in Figure 11, with all generation located at a central point. Heavy cables were required for distribution. Protection on remote feeders was problematic, as fault currents were limited by line-drop loss to a value close to load currents. In addition, the highly fluctuating loads resulted in voltage surges, causing erratic operation of magnetic control equipment.

The modernized d-c distribution system, as shown in Figure 12, is split into two load center areas, the Ivy Rock rectifier serving the area adjacent to the original powerhouse, with feeders to the plate mill, blooming mill, river pumps, etc., while the open hearth rectifier serves the open hearth, scrap yard, mould yard, stock yard, etc. Both areas are connected by a tie line consisting of the original open hearth d-c feeder lines.

To provide service during power outages and delays for maintenance of the rectifiers, and to utilize excess blast furnace gas (which is used to generate 25 cycle power), one of the 1000 kw 25 cycle motor generator sets was retained for standby or emergency use, feeding d-c power directly into the tie line connecting the two rectifiers. This connection provides flexibility in operation. The motor generator set can feed power into either bus by means of the sectionalizing tie breakers, it can be operated in parallel with either rectifier or both, as the occasion demands.

The motor generator set is located in the old powerhouse adjacent to the new powerhouse, and has been equipped for remote control, operating unattended except for periodic inspection. The remote control panel is located adjacent to the Ivy Rock rectifier control cubicle as shown in Figure 10. This panel has been equipped with ammeter, voltmeter, voltmeter switch for bus and generator indication, electrically operated rheostat control, d-c breaker control switch with dual red and green indication lamps for both positive and negative breakers, and a-c control switch with green, amber and red lights.

The set operates directly on 2300 volt, 25 cycle power, using auto-transformers for starting the synchronous motor. The generator is self-excited with the synchronous drive motor receiving field excitation from the generator.

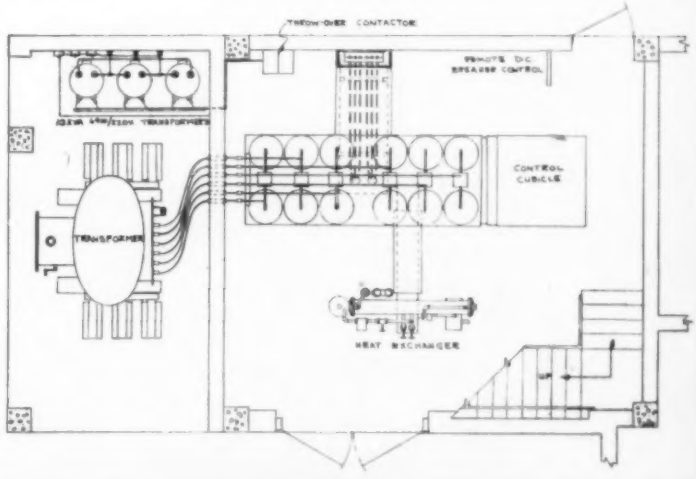
The scheme of operation is as follows: Upon standby, the generator disconnects and both field switches are closed. To start, the operator closes the a-c control switch, which closes both solenoid-operated breakers of the auto-transformers, giving an amber light indication at the a-c control switch. After a predetermined time interval, operation of a time relay and a rise of 80 per cent of normal generator voltage, the starting breakers are automatically tripped and the running breaker closes, giving a red light indication at the a-c control switch. The d-c voltage is then adjusted to approximately 5 volts higher than the bus voltage and the d-c breakers closed. Load can then be picked up by means of the rheostat control switch.

Figure 6 — Completed building at open hearth, which houses scale house and lavatories as well as the rectifier unit.

Protection is provided on the d-c breakers against reverse current and low voltage. If the operator attempts to close the d-c breakers with low generator voltage, only the positive breaker will close. Upon raising of the generator voltage, the negative breaker will close automatically; also, if the load is dropped to zero, the negative breaker will open.

The generator of this set is a standard flat compound machine. To adapt it for parallel operation with the rectifiers, which have a drooping characteristic, all that was necessary was to shunt out the series field by means of a single 4 in. x ¼ in. copper strap. The results obtained are shown by Figure 13. This curve shows an ideal condition for parallel operation of the two radically different conversion units on a highly fluctuating

Figure 7 — Plan view of open hearth rectifier installation.



load such as we have. It is apparent that, under 85 per cent load on the motor generator set, the set will lead the rectifier, carrying a greater percentage of the load swings; above 85 per cent, the set drops off rather steeply. This tends to stabilize the load of the motor generator set, letting the rectifier carry the swings and a proportionately greater part of the total load.

The parallel operation has proven to be very reliable, the load division remaining at the present value under all load conditions. As the automatic regulator on the rectifier carries the system voltage, no adjustments are required for variable load conditions.

The 250 volt d-c switchboard has been completely replaced with modern automatic reclosing switchgear of the heavy duty mill type. The d-c switchgear on the Ivy Rock rectifier consists of two 6000 ampere rectifier breakers, one 4000 ampere automatic reclosing breaker for tie line, one 4000 ampere automatic reclosing breaker for the plate mill, and three 2000 ampere automatic reclosing breakers feeding the blooming mill auxiliaries.

The d-c switchgear on the open hearth rectifier consists of two 6000 ampere rectifier breakers, two 4000 ampere automatic reclosing tie breakers (one positive and one negative) used for system sectionalizing, two 4000 ampere and seven 2000 ampere automatic reclosing breakers for miscellaneous open hearth area distribution.

The increased investment in this type of switchgear has been justified by subsequent operation. The severe operating conditions have caused occasional short circuits which have been interrupted before material damage was incurred by the equipment. Upon clearing the fault, the breaker closed automatically with little delay. In other instances, where moving cranes cause a fault and then swing clear, the breakers open upon fault, eliminating the possibility of a power arc, and when the fault is clear, close automatically.

A periodic check is kept of breaker operation and a report as to the number of operations is submitted to the maintenance foreman interested. By this means we have been able to correct some fault conditions before material damage is incurred by motors and control.

The plate mill feeder is an interesting example of cascade operation with an automatic reclosing main breaker. The automatic reclosing 4000 ampere breaker feeds directly into the bus of a metal clad switchgear

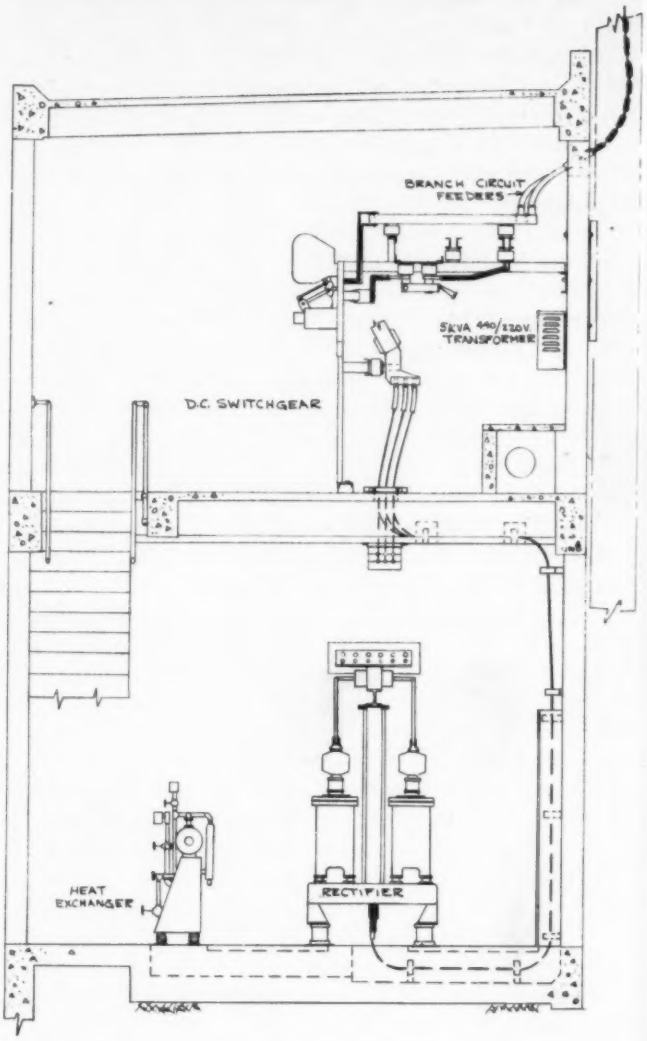


Figure 8 — Elevation drawing of open hearth rectifier installation.

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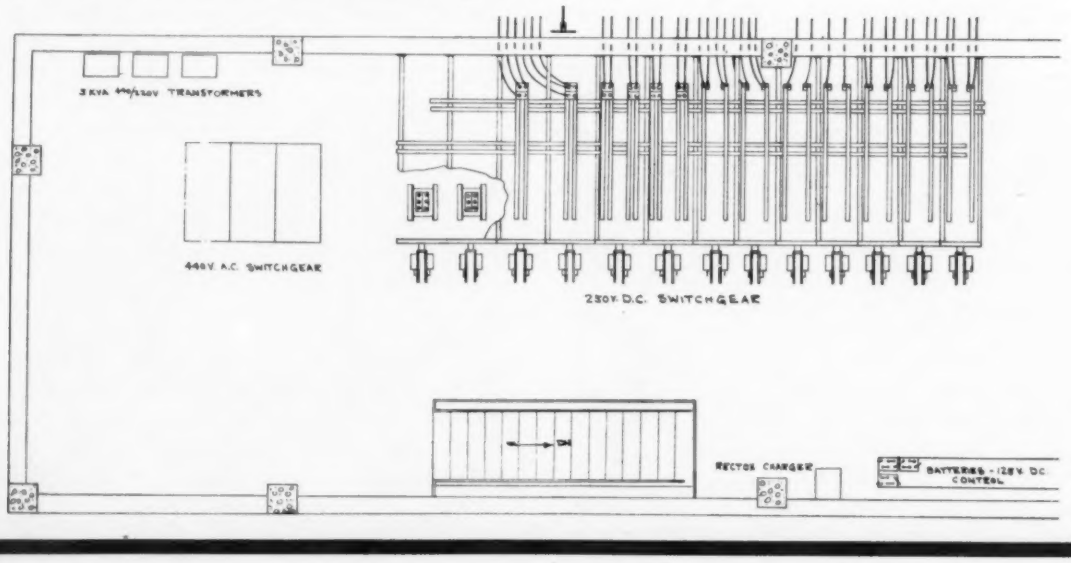
Figure 9 — Plan view of 250 volt d-c switchgear for open hearth rectifier installation.



unit over five parallel 500,000 cir mils cables per leg for a distance of 640 ft. The eight breakers are manually operated with inverse time trip attachments.

Operating experience has shown that in case of overload the feeder breaker will open, whereas a short circuit will carry through the breaker and trip the main breaker on impulse. The automatic reclosing feature then holds the breaker open until the fault is cleared or until the feeder breaker involved is opened, when the main breaker will close, restoring service.

We had one instance in which both the feeder breaker and the main breaker opened on short circuit. The main breaker reclosed immediately, restoring service on all circuits except the one involved in the fault. In this case we can assume that the fault current was of sufficient magnitude to actuate the magnetic trip of the feeder breaker in the extremely short time that it takes to actuate the impulse trip of the main breaker. We can only guess which breaker opened first.

The automatic reclosing feature of the main breaker consists of a load indication resistor rated 6.25 ohms, 40 amp, and connected in parallel with the breaker. A voltage balance relay is provided with the armature connected across the feeder line, and the field connected across the bus. This relay is calibrated to the circuit which it protects, and is variable from 4.9 volt at 4000 ampere to 18.5 volt at 1000 ampere. Upon fault conditions the breaker opens. The relay armature potential is the drop across the load, while the relay field potential is full line voltage. The breaker remains open as long as the armature coil potential is low. Upon clearing of the fault, the relay armature potential rises above the preset value, and the breaker is closed.

The rectifiers were placed in service in April, 1944, feeding into the old d-c distribution system. New feeders were installed one by one, paralleling the original feed lines to prevent interruption of service. As the new feeders were placed in service, the old were removed until complete segregation was accomplished, this phase of the work being completed in August.

During this transition period, numerable grounds and short circuits were caused by the live handling of the old cables. In a few cases these faults resulted in the loss of the entire d-c system. Service was restored almost immediately by reclosing of the rectifier controls. These accidental trippings have demonstrated without a doubt the ability of the rectifiers to pick up instantly the load of a heavily loaded system. Anyone who has tried to restore service on a steel plant system with other types of conversion can appreciate the advantage of this feature.

During seven months (May to November, 1944, inclusive) since the rectifiers were placed in service, the input was 7,350,010 kwhr, with an output of 6,442,830 kwhr, d-c. The load factor is 62.7 per cent, and the average efficiency 88 per cent. During this period the standby motor generator set furnished 2,226,100 kwhr of d-c power, being operated primarily to permit the use of excess blast furnace gas. A monthly tabulation of these values are as shown in Table I.

It will be noted that the highest operating efficiency period was during the first two months of operation. At the end of this period two 2500 hp, wound rotor induction motors were placed in service in the plate mill. These motors, due to their load factor, have a highly fluctuating power factor which causes a voltage variation of as high as 600 volts on our 6900 volt system. To compensate for this variation, it is necessary to operate the rectifiers with considerable grid bias, or regulating voltage, to stabilize the d-c voltage output. This use of increased grid voltage control results in considerably higher harmonics in the a-c side and more pronounced ripples on the rectified d-c voltage, which together apparently affect the accuracy of the metering sufficiently to cause efficiency readings appreciably lower than could normally be expected. This condition is temporary, as capacitors are being installed on the motor installation to correct the power factor, thus stabilizing the 6900 volt a-c system.

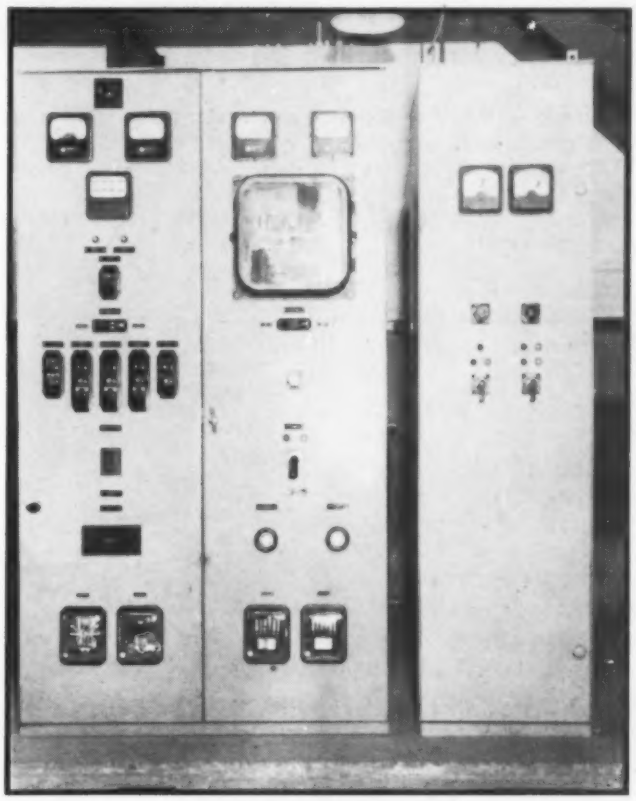


Figure 10 — Each rectifier control cubicle is arranged for local manual or remote automatic operation.

The load factors shown are averages. During peak load periods it is not uncommon to observe 1200-1400 kw on each rectifier. Momentary swings have gone as high as 1800 kw on one unit. During the construction of the early transition period when one rectifier was accidently tripped, the other rectifier carried the entire load momentarily until the tripped unit was put back on the line. During this period the load on the one rectifier was 2000 kw or better.

The rectifiers are proving to be extremely reliable. No difficulty has been experienced except that the small selenium rectifier units used for excitation were found to be defective. These units were promptly replaced by the manufacturer.

The Ivy Rock rectifier, being installed in the same building with the main switchgear and blooming mill reversing motor, is under direct supervision 24 hours a day by the powerhouse engineers. Being located adjacent to the 1000 kw motor generator set, load is varied

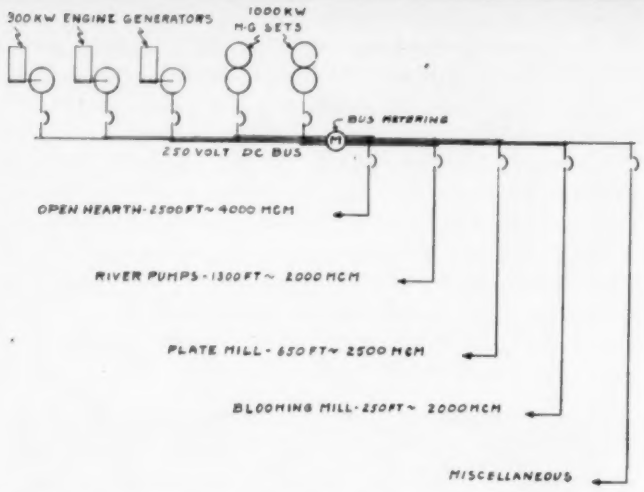
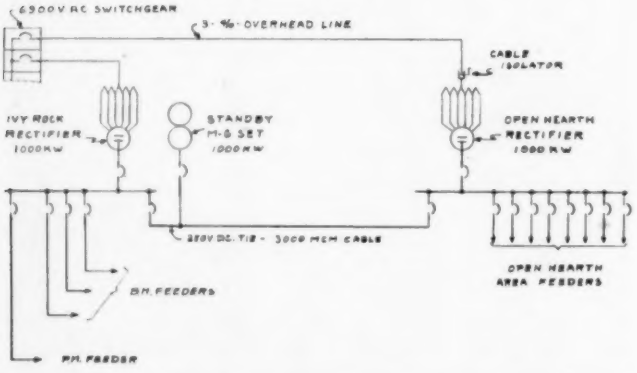

300 KW ENGINE GENERATORS
1000 KW M-G SETS
BUS METERING
250 VOLT DC BUS
OPEN HEARTH - 2500 FT ~ 4000 MCM
RIVER PUMPS - 1300 FT ~ 2000 MCM
PLATE MILL - 650 FT ~ 2500 MCM
BLOOMING MILL - 250 FT ~ 2000 MCM
MISCELLANEOUS

Figure 11 — Original 250 volt d-c system for steel work department.

▲

Figure 12 — Modernized 250 volt d-c system in steel work department.


6900 V AC SWITCHGEAR
3-¾" OVERHEAD LINE
CABLE ISOLATOR
IVY ROCK RECTIFIER 1000 KW
STANDBY M-G SET 1000 KW
OPEN HEARTH RECTIFIER 1000 KW
250 V DC TIE - 3000 MCM CABLE
BM. FEEDERS
OPEN HEARTH AREA FEEDERS
PM. FEEDER

in proportion to the availability of blast furnace gas. During light load periods over the week ends the Ivy Rock rectifier is deenergized and the motor generator set carries the load of this area.

The open hearth rectifier, being remotely located, is unattended and a daily inspection is made by the powerhouse engineer. Operation is continuous with little load variation due to operation of the motor generator set.

Maintenance to date has consisted of a weekly general inspection and cleanup period of approximately four hours per rectifier. This consists of checking the

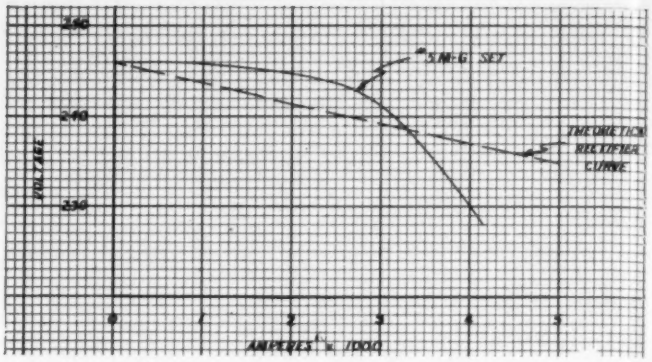


Figure 13 — Curves comparing characteristics of motor-generator set and rectifier.

water level of the closed cooling system, adding oil if necessary to the vacuum pump, checking all mercury seals of the tanks, and general cleanup. The work is done on the Ivy Rock rectifier during the weekend shutdown by the engineer on regular duty, and on the open hearth rectifier every Tuesday by the operating engineers on the swing trick. The open hearth rectifier is not deenergized during this period.

The reliability of the mercury arc rectifier has been proved by the operation of our open hearth unit. With the exception of the failure of the selenium cells no difficulty has been experienced. Initially the unit was deenergized every two weeks for a general check-up and test of relays, connections and auxiliary equipment. This period was extended to four weeks and is at present six weeks.

Operating efficiencies cannot be evaluated by comparison with the old system. The old motor generator sets were operated on power from our Swedeland generating station using a variable amount of blast furnace gas as fuel, whereas the rectifiers are operating on purchased power with a sliding scale rate which is affected more by the heavy mill motors than by the rectifiers. An evaluation of comparative conversion efficiencies is impractical at this time due to the temporary ow power factor of the system.

Therefore efficiencies of the new system must be evaluated in intangible factors, such as reduction in d-c line losses, higher and constant line terminal voltage, reduction in outage time, etc. Improvement here is apparent in the higher speed operation of cranes, the greater lift of magnets, and the continuity of service.

TABLE I

1944	Input, kwhr, a-c	Output, kwhr, d-c	Efficiency, %	Load factor, %	Standby M-G set generation, kwhr
May	1,028,000	945,760	92.0	63.5	257,900
June	1,204,400	1,108,050	92.0	77.5	74,200
July	1,217,700	1,020,040	86.0	75.0	177,700
August	1,328,640	1,138,400	86.0	76.5	76,800
September	793,170	692,150	87.5	46.5	597,500
October	842,300	733,900	87.0	49.0	562,000
November	936,800	804,530	86.5	56.0	480,000
	7,350,010	6,442,830	88.0	62.7	2,226,100

Efficiency varied from 86.0 to 92.0 per cent and the load factor from 46.5 to 77.5 per cent.

DISCUSSION

PRESENTED BY

F. O. SCHNURE, Superintendent, Electrical Department, Bethlehem Steel Company, Sparrows Point, Maryland

W. H. BURR, Superintendent, Electrical Department, Lukens Steel Company, Coatesville, Pennsylvania

C. L. EICHENBERG, Experimental Engineer, Bethlehem Steel Company, Bethlehem, Pennsylvania

GEORGE PFEFFER, Florence Pipe Foundry and Machine Company, Florence, New Jersey

W. A. SMILEY, Electrical Engineer, Bethlehem Steel Company, Steelton, Pennsylvania

L. V. BLACK, Superintendent, Electrical Department, Bethlehem Steel Company, Bethlehem, Pennsylvania

A. D. HOWRY, Plant Electrical Engineer, Alan Wood Steel Company, Conshohocken, Pennsylvania

F. O. Schnure: Mr. Howry has been able, due to the obsolescence of the steam plant, to adopt the load-center method of low voltage distribution to his plant. In this layout the mercury arc rectifier can be applied very nicely, not only because it is a reliable piece of equipment and gives little trouble, but also because hey operate unattended. Mr. Howry has made a very nice installation and is to be congratulated in having the courage to grab the bull by the horns in revamping this old d-c power system at a time when, undoubtedly, he faced a great many difficulties because of labor and material shortages and because of the fact that the job had to be done at a time when production was at its height and could not tolerate interference.

W. H. Burr: This paper is of especial interest to me because, during World War I, I was connected with Alan Wood Steel Company and operated the electrical equipment which has now been discarded. I want to congratulate Mr. Howry on the selection of a very efficient and very modern distribution system.

There are a few points on which I would like additional information. If Mr. Howry is free to discuss the costs of power, I would like to have the relative cost of his generated power as compared with the purchased power I would also like to know the rupturing capacity of the 6900 volt a-c breakers.

He also mentioned the cooling or ventilating system in his open hearth substation. It might be interesting to know a little more as to the type of filter and air distribution used in the open hearth substation.

C. L. Eichenberg: In as much as the rectifier does not operate as an inverter, what provision has been made to absorb energy returned to the line by dynamic lowering crane controllers while lowering heavy loads?

What effect does the fluctuation of a-c line voltage have on the operation of the rectifier and how does it affect the division of load between the rectifier and motor generator set when these two machines are operating in parallel?

How often do backfires occur, and how are such faults cleared? Are cathode breakers and grid blocking relays employed in the control circuit in order to relieve the conditions caused by backfire?

Under given conditions, what is the magnitude of current that can flow into a short circuit when the system is supplied by a rectifier as compared to a short circuit on a system supplied by a rotating machine of equal capacity?

George Pfeffer: Is it correct that as the load factor goes up, the efficiency goes down? Also, do you experience trouble paralleling the motor generator sets with the rectifiers, and vice-versa?

W. A. Smiley: To derive d-c power from a 25 cycle system of limited capacity and consequently of variable frequency, and to connect the synchronous motor generator set in parallel to a pair of mercury arc rectifiers working from a 60 cycle system, requires certain niceties of control, particularly so since the control is remote and automatic.

We know that the output voltage of the motor generator set is roughly proportional to the square of the frequency of the 25 cycle system, and that the voltage from the rectifiers is directly proportional to the voltage of the 60 cycle system, and this voltage is stated to vary with the load.

When one rectifier is delta connected and the other wye connected, and both paralleled over a tie line into which the motor generator set feeds, we have a complex problem in load division. Perhaps Mr. Howry could tell us how proper load division is effected as the load center shifts.

In speaking of the voltage regulation on his 60 cycle system, Mr. Howry stated that studies were being made to improve regulation by use of capacitors. In connection with a similar problem, where capacitors were already installed and 12-phase mercury arc rectifiers added to the system at a later date, oscillograms were taken of the currents to the capacitors. The wave form of these currents was rather disconcerting in appearance on account of the amplitude and variety of harmonics present. Although we have had the capacitors working under these conditions for several years without loss of any units, I would be pleased to learn the results of any studies Mr. Howry has made of this problem.

L. V. Black: I inferred from Mr. Howry's paper that Alan Wood operates on an ungrounded d-c system. I wonder if grounding either the positive or the negative lines would give any particular effect on the operation of the rectifier?

Another question is one of operating temperatures. Would the rectifier work equally as well in a room having a very high ambient temperature as in a room having a very cold temperature? How much heat is given off by the rectifier or is all the heat generated in the rectifier dissipated in the cooling system? What type of water is used in the heat exchanger, spring water or river water, and at what temperature?

A. D. Howry: I was expecting some of these questions relative to comparative power costs. Mr. Burr asked about the relative cost of power. I did try to mention in the paper comparative cost of the new as

against the old system, but at this particular time, as I stated, it is pretty hard to evaluate. The original operation being on the motor generator sets, using blast furnace gas for a variable part of the fuel supply as it was available and tapering off on purchased oil, introduces a variable cost. But to try to evaluate it in terms of dollars and cents and then attempt to compare it with the cost of purchased power, which is also available, according to the demand we have on the system, makes it almost impossible to form a comparison at this time. After a year's operation we may get a comparative figure on which to base costs. Our purchased power has been averaging 7.8 mills per kwhr up to this time.

Mr. Burr also asked about the rupturing capacity of the 6900 volt breakers. Those are 250,000 kva interrupting capacity of the air breaker type. He asked also about the ventilating system. The ventilating system in the open hearth building consists of air-conditioning equipment, with filters of the dry-type which are changed once a week. The ones that are removed are cleaned and replaced the following week.

Mr. Eichenberg asked about dynamic breaking load. That is one thing we were a little bit concerned about originally — what effect the rectifiers might have on dynamic breaking on cranes, etc. We found out by subsequent operation that we have sufficient load at all times on the system, consisting of lighting load and various pieces of equipment, to provide sufficient ballast for dynamic braking. We understood from the manufacturer that if we did run into trouble we could put a ballast resistor across the rectifier with little power dissipation. We haven't found it necessary to do that.

Mr. Eichenberg also asked about the voltage fluctuations. The rectifiers are equipped with d-c voltage regulators. They compensate for approximately 360 volt variation on our a-c side of the rectifier to keep a constant d-c potential. With that regulator we found that we have no trouble, providing our a-c voltage fluctuations are within those limits. The motor generator set running in parallel with the rectifiers has a synchronous drive motor, the speed varying with the variation of the frequency and not the voltage. I can't give any figures as to how much it does vary, but it is very little. Any differential in voltage caused there is compensated by the d-c voltage regulator on the rectifier.

Mr. Eichenberg asked about backfire. These rectifiers are 250 volt d-c, units which, due to their low voltage, are not critical to backfire. We have had no backfires up to now. At the time we were investigating the application of rectifiers we went into the system very thoroughly. We considered anode breakers, but checking past experience of the manufacturers and other customers on this low voltage application we could not see where we would be justified in spending the money for the anode breakers. Our operation has justified that stand.

Another question was whether one rectifier can carry the complete load, providing something happens to trip out the second rectifier. We have proved that by our operation. As mentioned in the paper, during construction we caused shorts in the handling of cables which tripped either unit. The operator, hearing the signal, closed his controls and put the rectifier back on the line. There is only one case I know of where we lost the second rectifier due to overload.

Mr. Eichenberg also asked about fault currents on the rectifier vs the motor generator set. Fault currents on the rectifier are limited to the capacity of the 6900 volt a-c system, and of course the reactance of the transformer. I am not qualified to go into how much current we can get on the rectifier during actual short circuit fault at the rectifier. We all know that the motor generator load is limited to the resistance of the windings and of course the stability in the generator itself.

Mr. Pfeffer brought up load-factor vs efficiency. The efficiency shown, as far as we have been able to determine, is a result of the variable power factor in our system more than any other cause. Lower power factor causes higher harmonics on our d-c system. The voltage control, or automatic regulation on the d-c system is controlled by the lagging of the power factor on the grid control of the rectifier, and when we have a low power factor on the system and the regulation is set to operate within certain limitations, we may get conditions that cause severe harmonics and false grid bias regulation, reducing the efficiency. That is a rather technical question. I would like to go into it thoroughly or have somebody answer it for me. The load factor of the rectifiers of course is determined by the amount of operation we have in our plant. That will vary directly with the demand. In addition it will vary in proportion to the amount of energy furnished by the motor generator set. It has no bearing on the efficiency. Load factor and efficiency are two separate items.

Mr. Pfeffer also asked about the parallel operation of motor generator set and rectifiers. I believe I mentioned that the d-c voltage will compensate for any differential in the operation of the two units. No difficulty is experienced in parallel operation at any load.

As far as load division between the two rectifiers, we found by experience that we can split our load by a small variation in the voltage. Our Ivy Rock rectifier area has more load than the open hearth area, so we carry the open hearth five volts higher than the Ivy Rock rectifier, transferring power from the open hearth to the Ivy Rock area. Both these rectifiers are on the north side of the river, in the steel works department. The blast furnace department is on the other side of the river and no work has been done on that system up to this time.

Mr. Smiley also asked about the delta and wye connection of the high side of the transformers. This was a requisite to the manufacturer. By putting one transformer in delta and one in wye we get the effect of a 12-phase rectifier. The main purpose of that was to reduce harmonics on our system, and of course eliminate any interference for radio or phone services.

Mr. Smiley also mentioned about capacitor installation. We are installing capacitors for two purposes: one of them is of course primarily to meet the penalty imposed by the power company for low power factor on the system. The other reason naturally is to reduce the voltage fluctuation to a minimum. I am particularly interested in the oscillographs Mr. Smiley mentioned. We have much knowledge to gain in that realm.

Mr. Black brought up the question about ungrounded d-c systems. I think that has been a controversial sub-

(*Please turn to page 87*)

PRODUCTION OF LIGHT-WEIGHT

Blast Furnace Slag

. . . . using a continuous machine process of dry granulation which offers control of moisture content and of cell structure, blast furnace slag is converted into a semigranular cellular material having great possibilities in the building field . . . .

by H. O. Wicks

HANNA FURNACE CORPORATION

BUFFALO, NEW YORK

▲ SLAG as applied to the blast furnace has been defined as the fused product formed by the action of the limestone flux upon the iron ore and fuel in the smelting process. Due to its varying complex chemical compositions and its costly handling in either molten or solid state, its disposal has always been a problem to the iron and steel industry. It might be of interest to repeat briefly a little of the history of some of the efforts that have been made to dispose of it.

In the early days of the industry, little or no attempt was made to utilize the slag. It was considered a necessary evil and was disposed of in the quickest, least costly manner possible. This resulted in its transportation in the molten state to various sites such as lake fronts, ravines, etc., which were of necessity located close to the plants, and gradually filling these to the level of the surrounding grades. Miles and miles of varying depths were thus filled in, until either the limits of practical transportation had been reached, or other reasons, such as natural or mandatory limits, forced plants to seek a new disposal outlet for their slag.

Many plants adopted a disposal method whereby the molten slag is either allowed to run into open pits adjacent to the blast furnaces, or is transported in ladle cars to dumps above grade and allowed to slowly air-cool into the solid state. The air-cooled slag thus formed is then reclaimed, crushed, graded, and disposed of as slag aggregate. In this form its uses are many, including aggregate for concrete, macadam road construction, and railroad ballast.

Another method of processing the slag is the wet granulated method, whereby the molten slag is allowed to run into a large pit full of water, or granulated by the use of a spray of water directed so that it strikes the molten slag as it flows from the runner into the granulating pit.

It was discovered that the suddenly chilled, wet granulated slag acquired what has been termed hydraulic properties, properties that exist slightly, if at all, in the slowly cooled, air-cooled slag. Briefly, a material having hydraulic properties possesses the phenomenon of hardening or "setting up" in the presence of water, similar to the well known portland or natural cements. Slag in the granulated form has been used as one of the ingredients in the manufacture of portland cement. When used in this manner it is burned in the usual way to form clinker which is then ground into cement. It was also discovered that the hydraulic properties of the granulated slag could be enhanced and accelerated merely by mixing a comparatively small percentage of other compounds with it. This led to the production of what is known as puzzolanic cement, a cement charac-

Presented before A. I. S. E. Buffalo District Section Meeting, November 14, 1944.

teristically weaker than portland but circumventing the costly burning process necessary in the manufacture of portland cement. This cement produces a white, non-staining mortar which enjoys a wide reputation in the brick mortar field.

The increasing uses of air-cooled slag in the heavy aggregate field and in the manufacture of cements have progressed a long way toward the satisfactory disposal of slag. In recent years however, some manufacturers have started using the dry grinding process instead of the wet slurry process in the manufacture of cement. This process cannot tolerate over three or four per cent moisture in the raw product. Thus the use of wet-granulated slag defeats the purpose of dry grinding, since it contains upward of 30-40 per cent moisture.

Prior to this, many developments were made in Europe relative to the disposal and utilization of slag, notably in Germany. Among these developments was a dry-granulating process and a new light-weight aggregate process.

While the German method of dry-granulation did produce a dry-granulated slag having hydraulic properties through means of a revolving drum and a cold air blast, it was never adopted in this country due to the fact that the grindability of the product was too high. The dryness was more than offset by the increased cost in grinding. However, a German process, or some modification thereof, of producing light-weight aggregate from slag has been adopted in this country. Meantime, many methods and machines were designed either to produce light-weight slag aggregate or dry-granulated slag. Since the light-weight aggregate field was new and seemed to hold the greatest promise, most emphasis was placed upon this.

In all the light-weight slag aggregate processes, advantage is taken of the fact that molten slag expands upon coming in contact with a limited amount of water, the amount of this expansion being more or less dependent upon the chemical composition of the slag. As the amount of this water is increased, the slag will reach a breakdown limit where it becomes granulated. The chemical composition of the slag may also vary to the point where little, if any, expansion occurs and breakdown or granulation takes place immediately upon contact with water. Two major processes eventually evolved from this fact and came into prominent use.

The first of these is a pit process, wherein the molten slag is admitted into a comparatively small pit which has been previously filled with water to a predetermined depth. This is a batch process, in that it is necessary to remove the expanded slag before more can be produced. No control, other than the first judgment is possible. The entire amount, usually a ladleful, is either passable or rejected. A large amount of "popcorn" slag, which is merely solidified foam with large irregularly sized cells and having little physical strength, is very apt to be produced. On the other hand, the moisture content of the finished product may run as high as 20-30 per cent. Generally, the cell structure of the finished aggregate is not uniform.

The second method, a continuous machine process, is far superior. Briefly, the machine consists of a stepped rotor having a series of blades on each step and enclosed within a corresponding, stepped housing. Molten slag is admitted, off center, in the top region. Through a series of nozzles, a controlled quantity of granulating water is also admitted in this same region. A semi-granular cellular material is discharged from the bottom of the machine. This machine operates successfully within that range of slag analyses wherein neither excessive expansion nor breakdown occurs.

In no prior method was it possible to attain definite control over the finished product, relative to either the moisture content or the structure. This led to the development of the Caldwell process of dry-granulation or light-weight aggregate production. Patents to the slag machine used for making this aggregate are controlled by the Celotex Corporation, who also distribute the finished product under the trade name of Celocrete.

A plant embodying the Caldwell process of slag disposal was installed at the No. 4 blast furnace of the Hanna Furnace Corporation in April of 1944. However, before going into the details of this installation, it may prove of interest to trace the origin of this process.

The Caldwell slag granulating machine, which is a part of this process, was developed by Wallace L. Caldwell of Birmingham, Alabama, and was originally conceived at the Wisconsin Steel Corporation, Chicago, Illinois, in 1932 as a light-weight aggregate producing machine. Further research and development on a light-weight aggregate machine was conducted at the Republic Steel Corporation, Buffalo, New York, in 1939. A year later the machine was developed and incorporated as a part of a dry-granulating plant at the Woodward Iron Company, Woodward, Alabama. In 1941, a pilot plant was set up at the Carnegie-Illinois Steel Corporation at Gary, Indiana. A complete, light-weight aggregate plant was placed in operation at the Troy, New York plant of the Republic Steel Corporation in March, 1943. The Hanna Furnace Corporation completes the sixth furnace plant where this process has operated.

The developers of this machine concluded from the very start that accurate control of expansion was necessary to arrive at a uniform product. Also, that in order to be successful the process would have to be operative throughout the different chemical analysis of slags as produced by a normally operating blast furnace. From the first experimental model, it was found possible to control either moisture content or expansion of the finished product within the machine itself. However, the uniformity of expansion or cell structure could not be maintained through the different analyses of slags. This led to the necessity of maintaining this control away from and independent of the machine. Aside from refinements, this principle of control is basic on all Caldwell installations.

The machine itself consists of a horizontally mounted, enclosed rotor with blades, suitably driven through a reduction drive and motor. Above this rotor is mounted an expansion chamber or enclosure having a smaller diameter than the rotor, the machine in effect being similar to a blower or centrifugal pump when mounted sidewise. The rotor is equipped with a conical "eye" at its center which extends up through the expansion chamber. The whole unit is water-cooled to withstand the heat of the molten slag. In operation the molten slag is admitted to the expansion chamber through a funnel opening off center from the "eye." Projecting into this molten stream of slag at the entry funnel is a

constant velocity, granulating water nozzle. This is the only point at which water is admitted to the slag. Depending on the character of the slag, it is either converted into "popcorn" or granules at this point. In either case, the "popcorn" or granules, or combination of the two, settle into the rapidly revolving rotor and are discharged tangentially from it. In the case when "popcorn" slag is formed, it is collapsed by the resulting centrifugal pressure occurring at the outer periphery of the rotor. Therefore, regardless of the original character of the slag, a hetrogeneous array of various sized particles or granules, either cellular or noncellular are discharged from the machine.

When this machine is used as part of a dry-granulated slag process, the quantity of granulating water, which also acts as a coolant to the slag, is adjusted so as to obtain any degree of moisture content desired in the finished product.

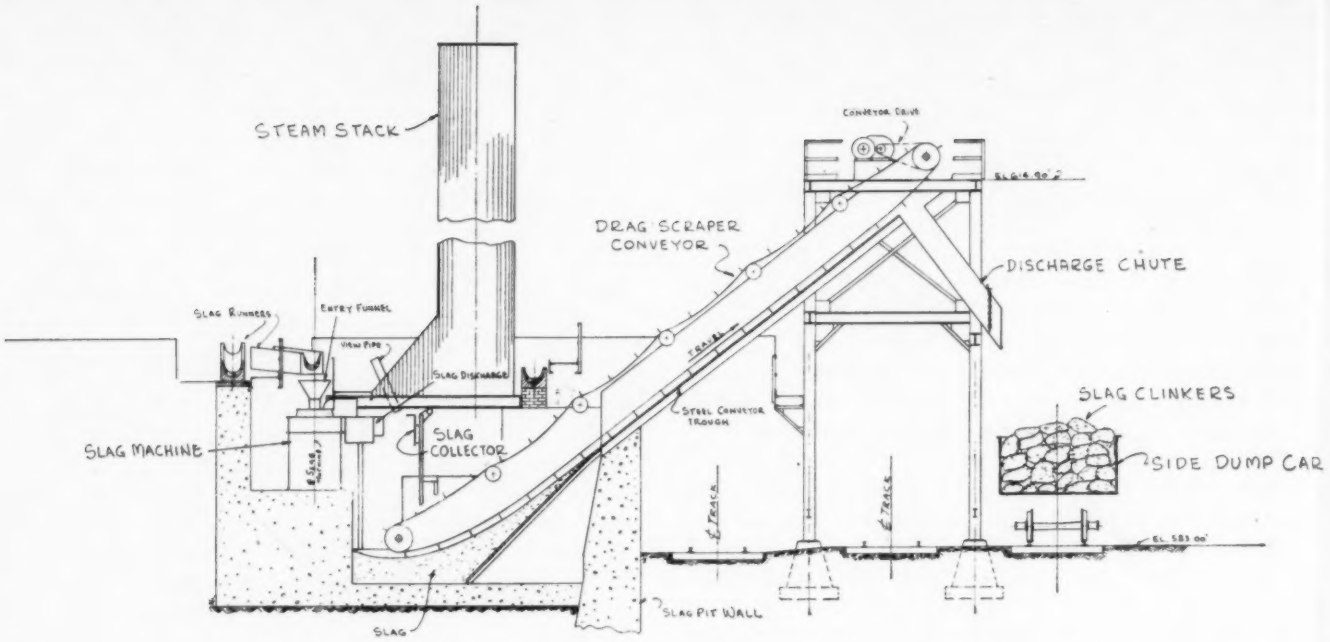
In the light-weight aggregate process, however, a collecting device is introduced into the stream of discharged slag pellets or granules, and the quantity of the granulating water is controlled to the point where these pellets agglomerate upon striking the collector. The resultant mass or clinker, as it is termed, is dislodged from the collector after it has reached a size of approximately one cubic foot.

Since the discharged pellets or granules may or may not be cellular in structure, it may be readily seen that the cell structure of the finished product is determined independently of the machine. These pellets or granules are discharged at a high rate of speed (over 100 fps) and at an incandescent temperature. When they collide with the collector and upon themselves during the formation of the clinker, a large percentage of voids occur between adjacent particles. Due to the high and concentrated temperature, the collected mass becomes semifluid, causing the voids and any cells within the individual particles to flow together and form spherical cells. These cells in turn subdivide until they can support the impact. The greater the impact, the smaller the cells, and conversely, the lesser the impact, the larger the cells become. Therefore, advantage is taken of this fact to maintain control over the cell structure of the finished product. Impact is increased and a smaller cell structure maintained by moving the collector toward the discharge area of the machine. The opposite effect is obtained by moving the collector away from the discharge area. In either case, the quantity of granulating water is maintained at the point where the discharged material agglomerates upon the collector. A piece from a broken clinker appears much the same as a solid rock except that it usually will float in water. Only the larger cells can be seen with the naked eye. When viewed under a powerful magnifying glass, the apparently solid rock appears as a maze of finely divided cells.

At the Hanna Furnace Corporation, the clinkers produced average 41 lb per cu ft as compared with the weight of molten slag which is approximately 130 to 135 lb per cu ft, making an expansion ratio of over 3:1 from the time the molten slag enters the machine until it is discharged in clinker form. In terms of the maximum processing capacity of our machine, which is 60 tons per hr, our clinker discharge rate exceeds 48 cu ft or 1¾ cu yd per min. A clinker is thus formed in a matter of seconds. It was a relatively simple matter to divert the molten slag through a conventional runner to the intake of the slag machine. However, beyond the machine we were confronted with a unique conveyor problem, not one of weight, but one in terms of volume, and of a material that defied all conventional conveying methods. Unlike conventional materials, such as coal, coke, rock, etc., a clinker is neither solid nor liquid; it is extremely harsh upon the surface, and refuses to roll or slide upon adjacent clinkers or to crush when it falls or becomes fouled in the conveying equipment. As it is produced, a clinker becomes a mass or chunk which has a relatively hard, rough crust and a red hot, semiplastic interior. Aside from the heat of the clinkers themselves, the conveyor is also subject to the possible accidental discharge of molten slag directly into it.

The complete light-weight slag installation at Hanna Furnace is located west of the No. 4 blast furnace, directly adjacent to the cast house and in part of the original air-cooled slag pit. No. 4 furnace was selected because it is our largest furnace and produces the greatest volume of slag. Slag is fed to the machine through a system of runners which are also arranged so that the machine can be bypassed if it becomes necessary, and the slag drained directly into the air-cooled pits where it is allowed to cool into air-hardened slag. At the present time, the slag discharged during the flushing period of the furnace is processed into light-weight slag, while that discharged during the casting period is allowed to run directly into the slag pit.

Slag flows from the blast furnace down the slag runner and into the receiving hopper of the continuous slag expanding machine.



Sketch showing general arrangement of equipment used in making and handling light weight slag aggregate.

The complete light weight slag processing unit consists of the slag machine, an inclined conveyor to convey the processed slag to side-dump cars, a plate type collector to collect the pellets or granules, and a vent stack and hood over the lower end of the conveyor.

The slag processing machine used with this installation, is rated at 60 tons per hr, has a rotor speed of 500 rpm, and is powered by a 60 hp, 1750 rpm, totally enclosed, fan-cooled motor. The machine is provided with a granulating water connection which is controlled by a lubricated plug cock. A window is provided on a view pipe that projects through the side of the steam stack adjacent to the operating station, affording the operator a view of the slag as it builds up on the collector while he may be varying the quantity of the granulating water to suit the flow of slag or the formation of the clinker, the quantity of granulating water being varied so that the slag will agglomerate on the collector. In installing the view pipe it was necessary to extend it inside the stack to a point close to the collector in order to pass through the blanket of water vapor occurring adjacent to and as a result of the relatively cool sides of the stack.

A drag scraper conveyor was selected, using two 6 in. pitch chains separated 3 ft 8 in. center to center, and with 6 x 6 x ¾ in. angle flights spaced every 3 ft. The tail shaft of the conveyor is located in a pit about 12 ft below the centerline of the slag machine discharge, while the head shaft is supported by a structural steel tower approximately 32 ft high. The conveyor flights run in a steel trough equipped with cast iron wear plates for the upper two-thirds of its length, and in a trough formed by the side walls of the foundation at the lower third. In order to compensate for the catenary contour formed by the drag chain of the conveyor, the bottom of the lower third of the conveyor trough was formed by allowing slag to fill in and be shaped by the chain and flights running over it. This conveyor has a speed of 50 fpm and is powered by a 20 hp motor through a drive chain and herringbone reduction drive. At the head end of the conveyor is mounted a fixed chute for discharging the processed slag into side dump cars on the track below. The conveyor inclines at an angle of 37½ degrees. While this may be a rather steep angle at which to convey conventional lumpy materials with this type of conveyor, no difficulty is encountered in the conveying of this material. This is due to the fact that this material has not the tendency to roll over itself or over the conveyor flights.

This type of conveyor was selected because it was rugged enough to overcome any overloading that might occur due to the semiplastic clinkers becoming clogged in the moving parts of the conveyor, and because it was able to clear itself in case a blow-through occurred in the machine and a sudden, large volume of slag was discharged onto it.

The collector for agglomerating the pellets or granules which are discharged from the machine is located above the conveyor and in front of the machine discharge at a distance of about 8 ft from the centerline of the machine. This distance was determined by trial and error until the desired cell structure of the slag was obtained. This unit consists of a flat plate with flared side wings to eliminate splatter of the slag pellets, and a leg to engage the passing flights of the conveyor. It is maintained in an approximate vertical position by bearings and a tension spring. Two striker plates are attached to the leg and positioned so as to engage the leg twice with each passing flight of the conveyor. The sharp return action of the spring aids in dislodging the clinker.

The steam or water vapor stack is arranged to completely house the lower part of the conveyor and slag machine discharge. To provide adequate draft for the

vapor which is formed in the process, a rather high stack was provided. The stack is approximately 57 ft high and is rectangular in shape. It consists of a structural tower, suitably braced, and with corrugated galvanized sheeting erected on the inside of the steel work as a protection against the corrosive nature of the vapor being removed. The stack is approximately 5 ft by 6 ft in cross section. The volume of vapor handled by this stack may be compared with that of a coke quenching stack.

After the slag has passed through the machine and has been loaded into side-dump cars, further processing into the finished light-weight aggregate is achieved by transporting it to a crusher plant which is located nearby. Here the slag clinker is passed through a conventional crushing and screening plant in a manner similar to rock or an air-cooled slag product. The high insulating value inherent in the cellular structure of a clinker causes it to become its own annealing medium. As a result of this, it requires from 5 to 30 hours, depending upon the depth the clinkers are piled, before crushing becomes practical. When a clinker cools, it fractures as a result of thermal shock, much the same as subjecting a highly heated piece of glass to cold water. These fractured pieces which resemble rubble in appearance, vary upward to 6 in. in size. Unlike crushing a semigranular expanded slag material, where many particles are carried over, still retaining fractures, the crushed particles from this material are physically sound. This assures maximum strength in the finished aggregate.

At present, the light-weight aggregate is finished in two sizes: coarse, $\frac{3}{8}$ in. to $\frac{1}{4}$ in., having a loose average weight of 27 to 33 lb per cu ft, and fine, $\frac{1}{4}$ in. to dust, having a loose average weight of 47 to 54 lb per cu ft. An interesting weight comparison may be made with gravel and sand aggregates which have an approximate loose weight of 90-105 lb per cu ft.

Light-weight aggregate is used in concrete where insulation and weight are a factor, and should find a wide use in this field both in plants making precast concrete products and in monolithic construction. In addition, through the use of different gradings, a vast unexploited field of uses becomes apparent. The exploitation of the light-weight aggregate field, and the production of dry-granulated slag as a puzzolanic material, plus the use of air-cooled slag aggregate may go a long way toward solving the problem of slag disposal.

DISCUSSION

PRESENTED BY

FRED REINHOLD, Anchor Concrete Products, Buffalo, New York

H. E. RAINER, Secretary, The Buffalo Slag Company, Inc., Buffalo, New York

Fred Reinhold: I was very much interested in Mr. Wicks' paper. Perhaps I had better give a history of the concrete masonry products industry before I go into the uses of this new light-weight cellular aggregate that is now on the market.

The concrete products business, producing masonry units commonly called the concrete block, was started some forty odd years ago. As I recall, the industry started as a backyard project. Perhaps many have seen some small plant, sometimes in the backyard of a man's home, tamping or molding what is commonly called oncrete blocks.

We have come a long way from that time, when a man tamped those blocks out by hand on a little machine that could be bought for $75 from Sears-Roebuck. He produced about 10 blocks an hour, or in an average ten-hour day, about a hundred units per day, as we call an 8 x 8 x 16 in. equivalent unit. Today we have a machine that will produce 600 blocks per hour, fully automatic, without manual labor. It is almost human the way that block comes out of the machine, is taken away and put on the racks and taken to the kilns.

We have come a long ways in machinery. We can go back and compare our prices of blocks in 1933 that were set by the NRA, with those of today. We are still selling at 1933 prices with a margin of profit, although we have more than doubled the wage rate in that time and materials have increased in cost by 40 to 50 per cent.

In the postwar period, it is our plan to be able to produce blocks even below the 1933 price, due to more automatic machinery going into the various plants throughout the country. The first light-weight aggregate I became acquainted with, was the cinder product. We took the raw clinker cinder coming from boiler houses and steel plants, and processed them through crushing plants, taking out excess coke and other deleterious materials.

We have been looking forward to a prepared aggregate, and I believe Mr. Wicks' paper gives the answer to many problems. Our product, made of sand and gravel into an 8 in. block, will weigh 45 lb. In the light-weight aggregate block, the same unit will run 27 to 29 lb. You can see the tremendous saving in dead weight in the construction of buildings. This will also reduce the steel cost in the construction of buildings. This new concrete has the advantage of being light in weight. It is light in color, but can be tinted by using color in the mixer. The finished product, as turned out, is practically white. The cinder block which we are making is sort of slate-blue color. Celocrete also is highly insulating. It has high acoustical value and contains no known materials which would be objectionable in concrete. It is fireproof and very flexible to handle. It can be sawed with a carborundum wheel very readily.

While attending the Building Products Executive Council Conference at Washington recently, some of the statements made concerned the rise in the market price of building materials. Lumber costs have increased 70 per cent since 1939; cement only $5\frac{1}{2}$ per cent; brick and tile concrete masonry units, 10 per cent; plumbing and heating equipment, $16\frac{1}{2}$ per cent. This is a very competitive market that will be launched when the European war is over. We are looking forward to a greater use of light-weight aggregate products.

There is only one comment I would like to add, and that is relative to the weights of the aggregate. As I have said, we have been looking forward to a good light-weight aggregate free from foreign substance. However,

we can go too far in the light-weight feature. I would suggest that weights be carefully controlled. We thereby will be able to make a stronger concrete masonry unit at a lower cost. The cement factor will be the principal factor in the cost of the masonry unit. If we can reduce that cement content, we will automatically lower our cost.

H. E. Rainer: This subject is of special interest to me because, approximately ten years ago when the development of expanded slag by various processes was being investigated, our company became interested in the subject. We were looking for new uses for blast furnace slag and new markets that might be developed. There were at that time as many as five different methods of expanding slag under investigation in different parts of the United States and Canada. We investigated all of these, and locally experimented with three of these methods.

During the winter of 1938-39, we heard of an experimental machine which had been built at the Wisconsin Steel Company for the expanding of slag, and in January, 1939, we visited Chicago and saw this experimental machine. It had not been fully developed and there was further research needed before the machine might be considered a success. Believing that this process had considerable merit, we arranged with the Republic Steel Corporation in Buffalo to permit us to bring the machine from Chicago and set it up adjacent to one of their furnaces for further experimentation. The expense of this installation and the operation of the machine, however, was borne entirely by our company. This period of experimentation continued for some six weeks, during which time various breakdowns and failures resulted, and the machine was finally operated to destruction. It was our opinion at that time that the product of the machine was one of the best, from the standpoint of quality and lightness of weight, of any of the expanded slags that we had seen. However, it was our opinion, at the close of the period of experimentation, that it would be most difficult to keep a machine in operation under the arduous conditions which were involved. The experience gained, however, during the six weeks period, resulted in the machine being completely redesigned and water cooling was adopted throughout the machine.

In the years prior to 1913, practically the only uses for slag in the Buffalo area were railroad track fills. Many wooden trestles carrying railroad tracks over ravines and valleys were displaced by fills of water-granulated slag. Two major railroad projects which used large quantities of granulated slag locally were the high speed trolley line from Buffalo to Niagara Falls and the exchange yards of the DL&W railroad with the New York Central railroad.

In the spring of 1913, the Buffalo Slag Company was formed and the first crushing and screening plant utilizing air-cooled slag was erected on the property of the Buffalo Union Furnace Company. Realizing that air-cooled slag had a commercial value and was useful as a highway material as well as railroad track ballast, the company proceeded to develop a market in these fields. In those early days highways were built of the water-bound macadam type, road material being compacted by means of rolling and bound by the use of fine screenings, moistened by sprinkling with water over the surface. Slag was found to be excellent material for this purpose.

Brick pavements were also being laid quite extensively at this same time, these pavements being placed on concrete bases. Steps were taken to have slag utilized as a concrete aggregate in these brick pavement bases. The results obtained from such concrete proved to be so satisfactory that, as years went by and the concrete pavement came into vogue, our efforts were bent upon having slag used as a concrete aggregate. Considerable sales resistance was met in this field, for in the Buffalo area, very little slag had ever been used in concrete. However, as a result of test sections of highways being built by the New York highway department in and around Buffalo, it was observed that slag concrete pavements gave a very good account of themselves, and slag was used to greater extent, not only for the base course but also for the wearing surface of concrete highways.

In the field of railroad ballast, there has been an ever increasing acceptance of crushed and screened air-cooled slag, until today practically every railroad radiating from this railroad center uses slag ballast. There is particular gratification in the fact that the railroads in recent years have been adopting slag as a concrete aggregate in their structures, one of the most recent examples being the grade crossing elimination project of the New York Central Railroad through Dunkirk.

Another rather extensive use of air-cooled slag through the years has been on built-up, flat roof buildings, where several layers of felt with tar or asphalt are placed and a coating of small size crushed slag is spread over the top as a protective measure to the felt.

Still another use that has been very interesting, although it has not resulted in large volumes being used, has been trickling filter beds in sewage disposal plants. Slag has been used in this field with marked success because of its durability and also because of its porous surface structure, which offers an advantage to the bacteria which clings to the surface of filter bed media.

A more recent development has been the use of crushed slag in black top mixes for the resurfacing of highways, as well as for a surface coating where road oils are used. In each of these uses slag is found to be highly desirable.

In conjunction with an affiliated company, we organized the Federal Portland Cement Company and erected a plant in 1926 to utilize slag in the manufacture of portland cement. The process adopted was quite new and operating problems developed which required a change in raw materials. However, slag is being utilized in the manufacture of special cements.

Slag is preferred in many areas of the country in the manufacture of rock wool. Due to its chemical analysis, it is found that slag produces a wool of light color and excellent texture. This is undoubtedly a growing field and future years will find increasing quantities of slag being used for this purpose.

Since the year of its inception in 1913, the Buffalo Slag Company has marketed, in round figures, 16,500,000 tons of air-cooled blast furnace slag, and in addition large quantities of granulated slag have been disposed of. The acceptance of properly prepared slag of stable quality for the many uses enumerated has been a source of considerable satisfaction.

WHAT *Stream Conservation* MEANS TO THE IRON AND STEEL INDUSTRY

. . . . much pollution can be eliminated by good housekeeping, by segregation and reduction in volume of wastes, and by controlling rate or time of discharge . . . . if the remaining pollution load is too great, some form of treatment is a necessary duty, and should be regarded as an integral part of the production process . . . .

by J. R. Hoffert, ASSISTANT CHIEF ENGINEER
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▲ IT is not the purpose of this paper to attempt any learned discussion of the technical problems of handling the wastes of the ferrous metals industry, but rather to consider the present state of stream pollution — or more properly, stream conservation; the present attitude of the public and the viewpoint and duties of public officials toward this subject; and what implications these hold for the iron and steel industry. Rather than trying to give the answers to some problems about which the industry may know more than I, I wish to stress the necessity for finding the answers to the problems and the possibility of doing this.

A great deal depends upon our viewpoint. Just as a mountain, a building, or roadside objects appear different as you approach them from different directions, so too do problems of stream conservation take on quite different aspects with different interests. It is therefore desirable to step out of the role of production engineers interested mainly in keeping the wheels of industry turning and holding costs at a proper level, and look at stream pollution through the eyes of the average citizen.

It is probably unnecessary to argue the value of clean streams — to point out the somewhat intangible but nevertheless vital value of clean streams and undespoiled woodlands in maintaining our physical, mental and spiritual health through recreating these values in our enjoyment of God's great out-of-doors, or to point out the readily appraised value of clean streams for their paramount use — public water supply — or their vital value for process water for industry. Those who have had to go to expensive treatment of water for process purposes in addition to that customarily needed for steaming purposes, or who have worried with clogged condenser tubes, excessive corrosion, or other troubles resulting from stream pollution and not from the natural salts in the water, know the cost of stream pollution.

Sewage pollution of our streams did not begin until the era of the water-borne carriage of household wastes, but industrial pollution began with the founding of our infant industries, when it was considered the right and proper thing to wash or dump their wastes into the nearest stream. Over the years this disposal has become so general that it is now looked upon by many as a vested right. Municipalities and private citizens alike followed this same practice with domestic sewage, and gradually matters became worse and worse until far-seeing people recognized that something had to be done to protect and restore our overloaded streams which in all too many cases had become little more than open sewers.

Through long years of agitation and zealous effort, statutes were finally enacted to control pollution and to

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supplement the common law, because the old law of the right of a riparian owner to the use of the waters of a stream in substantially their original amount and condition, modified only by the reasonable use of upstream owners, had proved insufficient to control stream pollution. And then began the effort to enforce those laws! For in this country of ours laws can be enforced only to the extent that the people as a whole subscribe to those laws. All too frequently the people who helped enact the laws and who wished them enforced against upstream polluters or against the usual "whipping boy" — the "industrial polluters" — claimed financial inability to prevent their own polluting wastes from injuring downstream parties.

In Pennsylvania the Purity of Waters Act was signed on April 22, 1905, following which the municipalities of the Commonwealth were notified by the Commissioner of Health to install sewer systems and sewage treatment works. Some communities did but many more did not. It was a matter of educating the public up to the point of recognizing the real necessity of correcting stream pollution, and of paying for it. But much water has flowed over the dam since then and conditions have changed greatly. Time does not permit elaborating upon the trials, failures and successes of the efforts to control and reduce stream pollution, but we can point out a few contrasts.

The sewerage sections of our old Purity of Waters Act were repealed and a new antipollution statute enacted on June 22, 1937. Whereas the old act defined sewage as the excrementitious or other bodily discharges of human beings and animals, the new act so defines pollution as to cover practically anything which injures a stream. Where the old act recognized only the public health, the new act is in terms of protection of public health, animal or aquatic life, domestic and industrial use of the water and recreation. The old act gave absolutely no control over industrial wastes unless they involved human or animal discharges, and specifically exempted wastes from tanneries and coal mines; the new law covers all industrial wastes, exempting acid coal mine drainage and silt only until, in the opinion of the Sanitary Water Board, practical means for removing their polluting properties have become known. The new law authorizes the issuance of permits to municipalities, institutions, corporations and persons; the old law provided for permits to municipalities only.

But more significant than the changed law — which is but a reflection of it — is the attitude of the public. There has been a general recognition, not alone by members of conservationist and wild life groups, but by the average citizen as well, of the fact that stream pollution must be controlled and reduced, and that our streams must be made fit for recreational use. The public is also coming to realize that waste treatment is a utility service which can and must be paid for in the same way that we pay for gas, electric, telephone, and other services. We pay for our potable water supply and expect to — we find the money to do it. By the same token we can and must pay for treating this same water after it has been made dirty by use, so that it will not injure some other party.

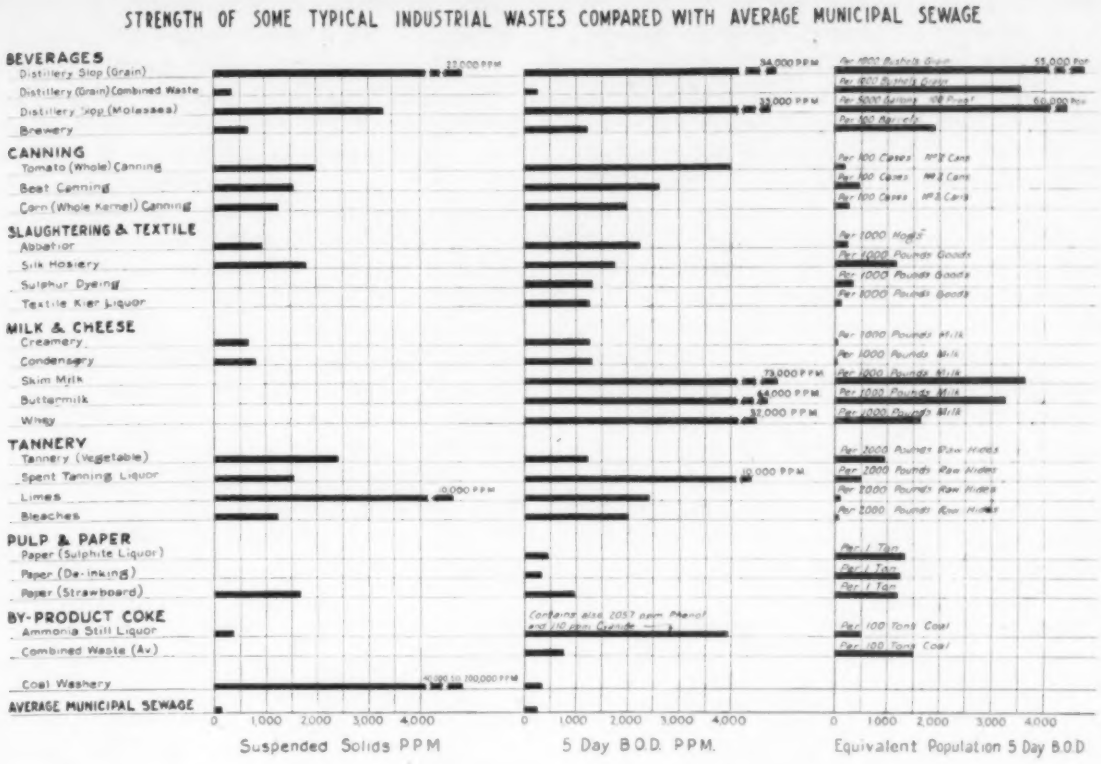
The public is demanding that our streams be cleaned and make no mistake about it, they will be cleaned up. Judge J. Kun in his decision of March 22, 1944, in the case of Commonwealth of Pennsylvania ex rel James H. Duff, attorney general, and the City of Philadelphia versus Philadelphia and Reading Coal and Iron Company, the Lehigh Coal and Navigation Company, et al, well summed up the situation when after various pronouncements upon the need to protect our streams, he said, "The people have the absolute right to have the 'ancient purity' of their streams preserved against all other considerations." As the great liberal, Justice Oliver Wendell Holmes, of the United States Supreme Court, said in the Delaware River case, "A river is more than an amenity; it is a treasure."

Now what does all this mean? The judges certainly did not mean that streams draining populous and highly industrialized drainage basins can be restored to their primeval purity, and common sense tells us that this cannot be required. But it does mean that the time has come when, as a matter of common decency, our sewage and industrial wastes must be given sufficient treatment to suit the use and condition of the receiving stream. There are plenty of teeth in our Pennsylvania law and those who have followed the various bills which have been repeatedly introduced into Congress know the efforts which are being made to take this matter out of the hands of the states and place it, with still more stringent laws, under the federal government.

I referred to the limited success secured under the old Purity of Waters Act in reducing stream pollution. During 1944 the Pennsylvania Sanitary Water Board, the State agency having jurisdiction over stream pollution, held a series of ten public hearings throughout the state to acquaint the public with the board's program for stream improvement, to afford all parties-in-interest an opportunity to be heard, and to meet certain legal requirements preparatory to issuing orders to municipalities and industries alike to submit plans for waste treatment works.

The board has undertaken this campaign for several very good reasons. It believes that the awakened social conscience of our people will support as well as demand stream clean-up. It knows that there is now adequate law to enforce this clean-up, and that satisfactory municipal tax collections, profits by industry, and sewer rental laws will now permit construction which was financially impossible for many when the law was enacted during the depression. The board also knows that there must be a large volume of worthwhile public works ready to be put under construction as soon as the war is over to afford employment for our returning service men and women and for our war workers during the interim between the close of hostilities and our return to a sound peacetime economy.

There are no more important works than those which affect our public health, such as waterworks and waste treatment plants. But modern works of this kind require careful planning to meet the engineering factors involved, such as volumes of flow, character of wastes, the most appropriate type of treatment, and many others, to say nothing of the financial and legal planning involved. Each project requires individual adaptation to its particular job and site; each must be covered by well prepared detailed construction drawings, and frequently the project is highly complicated in design, involving the latest knowledge of physics, chemistry, and engineering practice. The projects cannot be conceived



and the plans prepared in haste without suffering thereby. We want no more WPA and PWA overnight planning while men stand around waiting for jobs.

The board's public hearings have been followed by board action authorizing notices for the preparation of plans. Already a large group of municipalities have been called upon to submit plans, and orders to the others will follow as rapidly as they can be prepared. Similar notices are to be sent to industries which discharge injurious wastes to our streams.

On May 17, 1944, the board removed the exemption from the law heretofore enjoyed by silt-laden colliery waste waters, and by its order of June 7, the board specified the conditions to be met by such waters. It is a pleasure to report the generally hearty cooperation which the board has received from the coal industry. Already many plans for silt control have been submitted or are being prepared; some plants are already constructed or are being constructed; and many tons of small sized coal and silt which a short time ago were being dumped into our streams are being kept out. The board's order requires the construction of the necessary treatment works as rapidly as availability of labor, materials, and equipment permit after approval of plans. In some cases operators have constructed their silt control devices without awaiting approval and it is a satisfaction to note that a number of the collieries will discharge their waste waters back into the mine workings which, in general, is an ideal method where conditions permit this.

The board has in effect classified the streams of the state and requires that, as a minimum, all sewage discharged into streams shall be given what is known as primary treatment, meaning thereby the removal of practically all settleable solids and at least 35 per cent of the organic pollution load as measured by the biochemical oxygen demand test; adequate disinfection is required where necessary to control disease germs, and of course, removal of toxic substances. Where the stream is so clean, where protection of waterworks makes it necessary, or where the volume of stream flow is so low or the pollution load of the wastes is so high, complete treatment is to be required. This means the removal of practically all suspended solids, 85 per cent of the organic pollution load, adequate disinfection, and freedom from toxic substances. For intermediate conditions, intermediate degrees of treatment are required. Only in the case of those streams now so heavily impregnated with acid mine drainage that treatment of wastes discharged thereinto would not be in the public interest will treatment not be required.

Industries will be required to treat their wastes to a degree comparable to that given sewage where methods for such treatment are known. Where these methods are not known, the industry will be allowed a reasonable time in order to devise such methods with dispatch. In some cases, of course, such as those wastes containing only settleable solids, "primary treatment" will also be complete treatment.

On the other hand, the so-called complete treatment or 85 per cent BOD removal may not be sufficient. For instance, distillery slop has a pollution load about 125 times that of average municipal sewage; cheese whey wastes are about 150 times as strong as such sewage; and by-product coke plant wastes containing phenols can cause very objectionable tastes and odors in public water supplies in very low concentrations. In the case of such wastes a residual of 15 per cent would still be too high a load for many of our streams. Again, BOD may not be a proper measure of the pollution load. Thus, the BOD of metallurgical pickling liquors is no proper "yardstick" of its pollution effect. And BOD may or

may not be a proper measure of, say, toxic plating liquors or certain chemical wastes.

The board is fully cognizant of the situation respecting priorities, labor, critical materials, and the other difficulties, and does not expect much actual construction for the present. What the board does expect, however, is well prepared plans ready to be put into construction as soon as possible.

Now what implication does all this hold for the iron and steel industry? To answer this let us first ask "What is pollution?" At the risk of stating the obvious, let us say that pollution is anything which interferes with a legitimate use of the stream — anything which soils or spoils that stream. It may be foul putrescibility; it may be something inert which silts up the stream; it may be largely offense to the aesthetic.

Not many years ago, the iron and steel industry had soft grey, strong grey, and chilled or white cast iron, malleable iron, wrought iron, and cast steel, and "tank," low, medium, and high carbon steels, with a limited amount of nickel and manganese steels for special purposes. Today, alloy cast irons run the gamut of alloying elements, and heat treatments fit many of these irons for special services. The SAE and other special steels are alloyed or purified by one or more of about a dozen different chemical elements; they are heat treated, often in special atmospheres, for control of physical requirements, and generally are "tailored" for their particular job from ingot, through rolling and drawing practice, to final temper, grain size, etc. The electric furnace is used for melting to improve the quality of products. Engineering specifications and an educated "trade" expect and demand this. Just so, there has been a stepping up of public demands regarding water supplies and wastes disposal. Not many years ago the public's great goal was a bacterially safe water supply. Next the people demanded a clear and sparkling water. More recently they have become extremely critical about the tastes and odors in potable water supplies, and now there is an increasing demand for a soft water.

So too have public demands for pollution abatement advanced with the times. No longer do the people want to see their streams alternate between the hues of the rainbow from textile dyeing or paper making; or see the streams covered with foam from glue manufacture, from tall oil soaps or other by-products of pulp mills; or rusty red from precipitated iron salts from metallurgical pickling liquors; or see an oil sleek from refinery waste waters which is often heavy enough to foul fishing tackle. It will be well to remember that the required standards are constantly rising.

Of course there is a practical limit to all requirements, and the public's desires are not necessarily the final criteria. Requirements must be reasonable; they cannot be confiscatory. We cannot injure industry, for after all industry is just another name for all of us, since it is the life-blood upon which our economic life depends. But industry would be doing itself a disservice if it so failed to meet within all reason the advanced public demand for stream cleanup that it brought down upon itself an aroused public resentment in the form of unduly onerous legislation.

Now, what are the different kinds of pollution — how can we classify them? Well, we can do it in various ways but for a simple analysis let us group them roughly as follows:

1. More or less inert particles, large or small, suspended in the waste waters, such as clay and fine sands from quarries, sand and gravel washing plants, colliery silt, blast furnace flue dust, foundry sand reclaiming washers, etc. The solids may be "settleable" solids or "suspended" solids, or colloidal particles, depending upon their size, but usually genuinely quiescent sedimentation will remove all of these except the colloids which will usually require additional treatment such as chemical precipitation. Wastes of this type, even though occurring in nature, are objectionable because they cause shoaling of the stream and cover over its bed thereby destroying the aquatic life, or the "garden of the stream," upon which fish life depends.
2. Oxygen-consuming putrescible wastes such as sewage, tannery and abbatoir wastes, distillery and brewery wastes, cannery, milk handling and pulp mill wastes, and many, many more. This is the type which you generally think of when you speak of "pollution." Treatment of such wastes covers the whole range of treatment processes. Quite generally it involves quiescent sedimentation coupled with some form of biological treatment, although for industrial wastes, evaporation or other treatment to produce a useful by-product is frequently the answer. This type of waste is particularly objectionable because it robs the stream of its dissolved oxygen, upon which fish life depends, and if in sufficient volume, can turn the stream into an open septic sewer, full of foul odors and growths of sewage fungii.
3. Oxygen consuming non-putrescible wastes, such as acid pickling liquors, certain explosives, by-product coke wastes, and numerous other chemical waste waters which, by chemical demand such as by hydrolizing salts, abstract oxygen from the stream.
4. Chemical wastes which, because of their acidity, causticity, or other properties per se, affect fish life or interfere with the use of the waters of the stream.
5. Toxic substances such as the cyanides and chromates of plating solutions and from some furnace operations, copper from munitions and other manufacture, certain dyes, agricultural sprays, and other wastes which are poisonous to animal or aquatic life.
6. Foaming and filming pollutants, such as some glue, pulp mill, textile, and other wastes; oil well and oil refinery waste waters; cutting oils and compounds; machine and locomotive lubricants and wash-down waters, etc. These may or may not involve emulsions and usually require separators of various types, some complicated by emulsion breaking devices, and sometimes chemical or other emulsion breaking measures.
7. Taste and odor producing wastes, such as gas and by-product coke wastes and many others, singly or in combination. When it is remembered that phenols in the unbelievably small quantity of 2 parts in a billion can cause detectable chloro-phenol tastes in public water supplies, the need for careful control of these wastes is readily recognized.
8. Miscellaneous pollutants, including spent dyes which color the stream, and others not included in the foregoing group.

Of course, it is understood that a great many of the polluting substances fall into several of these categories. Sewage contains settleable, suspended, and colloidal solids, oxygen consuming putrescilibity, often "chemical" wastes, etc.; by-product coke wastes consume oxygen and are notorious for producing tastes; pulp mill wastes include many categories; and so on.

Now that we have defined and classified pollution, what can we do to reduce and control or eliminate it? The first and most obvious, but so frequently neglected, thing is plain, ordinary "good housekeeping" — stopping the waste of oils to sewers, stopping or collecting drippings from pipe lines, disposing of wastes where they will not be washed into a stream, and, in general, keeping the plant, grounds, and equipment in good order and clean so far as wastes are concerned.

Next, we can segregate wastes and keep the real offenders unmixed with weakly polluting or clean waters, such as uncontaminated cooling water, surface, and rain water, etc., thereby reducing the volume of polluting wastes which must be treated or disposed of. And, incidentally, see to it that thermal exchangers and other devices do not leak polluting wastes to clean cooling waters.

Then we can reduce the volume of polluting wastes in many cases by recirculation or by actual reduction in the amount of water used. It is sometimes surprising how much can be accomplished in this direction when a real study is made of the subject and established customs are reexamined in an unbiased and realistic way. This has been done, for instance, at pulp and paper mills and at many other plants.

We can also control rates and times of discharge. Instead of alternately discharging alkaline and acid wastes, we may be able to combine them and thus partially or wholly neutralize them. Or instead of quickly dumping a vat of wastes, we may discharge it slowly or discharge it to a holding tank or basin and let it flow to the stream over the full working day. Or better still, we may extend the discharge of the working day's wastes over the full 24 hours by means of floating drawoffs, orifice controls, etc. Or we may discharge the wastes to a holding lagoon during low or ordinary stream stages and release them only during flood or high flows.

Obviously, if we extend the wastes of 8 hours production over 24 hours of stream flow, we have in general, except for the effect of depositing solids, cut their effect upon the stream to one-third. The effect of wastes discharged only during high stream stages is reduced in proportion to their dilution.

Again, it is possible at times to make process changes in the mill which will greatly reduce the pollution load from that plant.

And then, when we have done everything possible to reduce the pollution load of industrial wastes by good housekeeping, by segregation, neutralization, and reduction in volume of objectionable wastes, and have taken any possible advantage of control in rate of discharge or changes in process, if the pollution load is still too great, we must provide some form of treatment. It is true that for some wastes we do not yet have satisfactory methods of treatment, but we do have such methods for so many of these wastes that, when combined with the foregoing measures, most wastes can be successfully handled. For the others, we must find the methods, meanwhile doing the best we can to control the harmful effects of such wastes.

It is well to bear in mind at this point that under the present law an industrial waste which is now being discharged to the waters of the Commonwealth must be satisfactorily treated before it is discharged, whenever the Sanitary Water Board declares that such discharge is or may become inimical or injurious to the public health or to animal or aquatic life, etc. Also, that all industrial wastes discharged from establishments opened after June 22, 1937, or discharges from plants reopened after having been closed for over six months, must be treated before such discharge in works approved in a permit from the Sanitary Water Board, and that the owner of the establishment must publicly advertise his making of an application for such a permit.

One of two tray thickeners, 60 ft in diameter x 38 ft high, which recovers flue dust from gas washer water. The pug mill in the foreground mixes dry flue dust with the filter cake.

▲

This small, modern plant affords a high degree of treatment for wastes from a milk plant.

It is likewise well to remember that a waste which is per se pollution as defined in the law is declared to be a nuisance whether or not the board so declares it. Also, that the "waters of the Commonwealth" are defined to include all surface streams, springs, lakes, ponds, dammed water, and all underground waters.

We have no wish to raise any false hopes. In many cases the treatment of waste waters will place an additional cost upon the product — but one as legitimate as the costs for the labor and materials which go into its manufacture. In other cases, useful by-products will enable the industry to break even, and in still other cases the treatment will result in a substantial profit, direct, indirect, or both. And it will be surprising how many cases of profit there will be when enough study is put upon industrial wastes to take advantage of all the possibilities for recovery of valuable returns.

For instance, we tried for some time to have a very large steel plant do something about its blast furnace flue dust which caused turbidity in the receiving stream and seriously shoaled its channel. But the company felt that treatment works would be too expensive. However, about a year ago that same company did install modern blast furnace flue dust recovery works at a cost of $516,361 — quite an outlay. But the pleasing thing was that not only did these works remove the turbidity and the depositing of solids but, after deducting the cost of operation of the plant and the cost of sintering the recovered ore dust, the plant showed a profit of $580,636 in the first year. Furthermore, whereas the mill's process water derived from the river formerly contained 13 grains per gallon of solids — 145 tons of dry solids per day, after operation of the treatment works this water contained only one grain per gallon. This indirect profit has been a very great benefit indeed. Hence, it is not surprising that the mill then put a shovel into the stream and recovered 15,000 tons of dust which had previously been deposited in the stream.

We all know the value of dried milk for human and animal food, but we also know that lots of skim milk has been dumped to the streams because some milk plants did not feel that it paid to save it. True, it requires apparatus to handle it, but does it require too great an imagination to think that some way can be found whereby the great food value of this milk and that of cheese whey, buttermilk, etc. can be saved, even at small plants, if they are not permitted to dump this to the nearest stream? Admittedly, the economics are very important. Maybe the cost will equal or somewhat exceed the value recovered, but maybe, too, smaller processing equipment or a collection system and the processing of the "wastes" at a central plant are the answers. American ingenuity has usually found an answer to whatever has to be done.

About 50 per cent of the weight of the log goes out in the wastes of a paper pulp mill, and its wastes, particularly from the sulphite process, are especially gross pollutants. Yet those sulphite wastes contain sugars and a host of other potentially valuable constituents. Much time and money have been spent on trying to unlock these potential values without yet finding the answer. But do you think that, if the same energy had been devoted to this matter that has been spent on improving the product and reducing costs of production, we would not be farther along towards the answer?

Nickel derives its name from the fact that ores containing it caused the early smelters so much trouble that they thought Old Nick himself was in the ore. But today nickel is one of the metallurgist's most valued materials. Many years later Monel had his own problems with nickel ores containing copper but he tackled the problem and developed the copper-nickel alloy which bears his name.

Distillery and brewery wastes are notoriously strong pollutants, yet when concentrated and converted into high vitamin stock foods they yield a very pleasing direct profit. And so we might go on, telling of the possibilities of many other wastes.

Much time and money has been expended in seeking a really satisfactory answer to the pickling liquor problem. These wastes can and are being treated to prevent stream pollution, but generally at a direct cost to the industry. And until a better method can be found, the industry will have to pay the price. But isn't it obvious that somewhere there is a better answer and that it behooves us to find it, just as we must also find the answer to the problem of acid mine drainage, however difficult that admittedly is?

Of course, in some cases objectionable wastes have been discharged into the underground, sometimes with considerable success. However, this method is in reality disposal and not treatment, and is not without considerable risk, especially in limestone regions where channels in the limestone strata act like pipes and may carry the underground flows for miles. The experiences of a cement mill, a ferro-manganese furnace, and many other plants prove the dangers which may arise from underground disposal of wastes. And obviously such disposal pollutes some underground waters somewhere.

To conclude, I give you the challenge of what is at once a great responsibility and a great opportunity — the duty of cooperating to improve and protect our God-given heritage of streams for the benefit of all, and the opportunity to show what our American ingenuity can do to make a virtue of a necessity — an opportunity to exemplify that proud American boast: "The difficult we do at once; the impossible takes a little longer." American industry has met every challenge to date and I am sure it can and will meet this one.

DISCUSSION

PRESENTED BY

N. C. BYE, Chief Engineer, Henry Disston & Sons, Inc., Philadelphia, Pennsylvania

L. B. PATIN, Consulting Engineer, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania

L. F. COFFIN, Superintendent, Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland

L. J. GOULD, Assistant Chief Engineer, Construction, Bethlehem Steel Company, Bethlehem, Pennsylvania

J. R. HOFFERT, Assistant Chief Engineer, Commonwealth of Pennsylvania, Department of Health, Harrisburg, Pennsylvania

W. C. SCHULZ, Superintendent, Power and Maintenance, Bethlehem Steel Company, Steelton, Pennsylvania

L. V. BLACK, Superintendent, Electrical Department, Bethlehem Steel Company, Bethlehem, Pennsylvania

J. E. GOLD, Chemist, Bethlehem Steel Company, Bethlehem, Pennsylvania

G. T. WILLIAMS, Superintendent of Blast Furnaces and Coke Plant, The Youngstown Sheet and Tube Company, East Chicago, Indiana

R. J. GRAHAM, Lubrication Engineer, Bethlehem Steel Company, Johnstown, Pennsylvania

J. HELLMAN, Superintendent of Water, Bethlehem Steel Company, Sparrows Point, Maryland

A. J. FISHER, Fuel Engineer, Bethlehem Steel Company, Sparrows Point, Maryland

WM. P. HILL, Assistant Superintendent, Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland

N. C. Bye: The problem of stream pollution is a serious and a difficult one. It is serious because of the far-reaching effects of the pollution and difficult because of the manifold problems involved in its correction. The regulations are very confusing in many minds because the standards vary, depending on local conditions, and the requirements of purity in one case would not apply in another. The methods of correction also are not fully developed and in those cases where corrections have been made, it has been on individual applications of large size and not for universal use.

In industries such as the coal industry, the large steel industries, paper and pulp, and others, the problem is large enough so they themselves can spend considerable time and research to correct their particular troubles, such as pickle liquor reclamation, flue dust recovery, etc., but the smaller concerns cannot afford to spend the money for research and equipment for their problems because the cost does not go down in direct proportion to the size of the plant or the quantity of material handled. In addition, the smaller industries are usually situated in congested areas and many times do not have the space to put in the necessary equipment and this still further complicates their problem.

As there usually is no universally accepted method of making corrections for pollution, this lack of ability to individually develop methods handicaps these smaller concerns. Speaking specifically for them, it seems to me, that the trade associations of their industry could certainly work with Mr. Hoffert in giving advice as how to correct particular problems. In some cases, it may even turn out to be a community problem, because there may be several concerns in close proximity who have a sludging condition and it may be possible to combine two or three of these industries into one sludge handling problem in order to be able to afford the cost of corrective equipment without excessive cost to any one individual concern. The same condition would probably be true of the oil and acid problems, although maybe in a smaller proportion.

Smaller industries are 100 per cent in sympathy with what is being done but I believe they feel a little helpless as to how to correct their particular problem. If there were a setup, whereby a number of concerns could work together as a group toward this correction rather than as independent organizations such as the larger industries are able to do, I believe such practice would further the work which is being done along these lines considerably.

L. B. Patin: In Pittsburgh we have had some experience with the Sanitary Water Board and the Department of Health and, to the extent of my knowledge, they have always been willing to go along in attempts to arrive at a reasonable solution of any problem. In one particular instance, where it was impossible to go through with the type of program originally required, approval was given to proceed with a modified plan on a much simpler basis.

There are good reasons to justify the belief that the Board will be reasonable if one can indicate what his problems are and what method of procedure he proposes to follow.

L. F. Coffin: It seems to me there is one point that needs a little more emphasis on this subject of stream pollution. Mr. Hoffert has dwelt on the subject of stream pollution more from the point of view of public and recreation and water supply purposes than from that of the industry itself. On a stream where the water is used and discharged back into streams, and the process repeated, it seems that in many cases the accruing advantage, to industry itself, of getting better water should be, and I believe will be as years pass by, one of the most impelling reasons for cooperating with purification agencies.

Too frequently, when we pump water into a pipe we feel the problem is solved — all we have to do is put the water into a pipe. We have little regard for what happens to the pipe or our utilizing equipment because of polluted water, and the hidden losses from that source alone in industries are incalculable.

The larger companies are finding that the services of water engineers are absolutely compulsory in order to reduce these losses.

L. J. Gould: We ran into those problems in all of the shipbuilding areas because of the fact that in all of them there was a sudden increase in the number of people that spent their working day in a relatively confined area and in most cases the town sewers or city sewers were not adequate to handle those wastes. In San Francisco Bay, for instance, which is a large body of water, we found that the tide coming in was more than odorous. The solution in several of those places was simply to put the pipe line further overboard, so I suppose it went down to some other beach.

In the New York area the plants were required to connect with the sanitary sewer system even when it meant pumping. It is true that in the Hoboken area the sewer main itself then delivers overhead, but in the future they plan to correct this. At Fairfield in Baltimore, with 40,000 people there and no sewage system connected with that area except an open drain, we tried the experiment of an out-sized septic tank with unexpected success. There are two tanks that are about 30 ft wide and 150 ft long, just below the ground level, with a deck designed to carry storage of plates. The surprising thing is that, calculating on the basis of such information that was then available as to quantities of sewage daily, we had estimated the tanks to have a storage, up to the danger point, of six months, whereas it was actually not full after one year's use.

The army engineers and others connected with the encampments have had studies made of these problems

and the records we could have used so well three or four years ago are becoming available now, as to the actual drinking water required and the rest of the information as to requirements of large groups of people. Mr. Hoffert's paper referred to the BOD as one limiting factor, but is there a standard limitation of the BOD?

J. R. Hoffert: We have specified a BOD reduction of not less than 35 per cent for primary treatment, and not less than 85 per cent for complete treatment. Of course, BOD is not always the proper criterion.

L. J. Gould: Are you referring to the condition of the incoming water?

J. R. Hoffert: I was referring to the reduction in the pollution load of the industrial waste. For primary treatment there is to be a removal of not less than 35 per cent of the total number of parts per million of BOD in the raw wastes of the industry; for complete treatment, a removal of not less than 85 per cent of the total BOD of the raw wastes.

L. J. Gould: That is regardless of the BOD at the time you start to remove it?

J. R. Hoffert: I am glad you asked that question because it brings up another qualification. So far as an industry is concerned, it is responsible for what pollution it adds to a stream, not for what some upstream polluter has previously placed upon the stream. It is the Sanitary Water Board's job to look after the latter pollution. However, you will recall that I said the plant effluent had to be satisfactory for the stream. In some cases where you have a very high raw BOD to begin with — as, for instance, distillery wastes — if you were to take out only 85 per cent, you still have left 15 per cent of that very high original 85 per cent BOD, and that might be too much for the receiving stream. In such a case a higher degree of treatment would be necessary. Thus, the Board requires a reduction of 95 per cent in distillery slop.

The answer still is that we must gauge the treatment requirements by the needs of the receiving stream.

L. J. Gould: So there is no definite regulation as to acid content or parts of BOD, etc.?

J. R. Hoffert: The requirement will vary with the particular type of waste and with the requirements of the stream. For instance, with a large stream, primary treatment may be all that is necessary. On a smaller stream a residual of 15 per cent may be readily assimilable without detriment, whereas on a very small stream, such a residual from a very strong waste might make it just an open sewer.

W. C. Schulz: Perhaps Mr. Hoffert could give a quick classificaton of the various streams that would be of help to Mr. Gould.

J. R. Hoffert: I can't attempt any detailed explanation of that classification, but, in general terms, for those streams which are now clean streams or which are very small, or where the pollution load would otherwise be too great or where protection of a public water supply is involved, complete treatment of 85 per cent or better is required. Major streams, which are visibly clean — the kind you would look at and say, "They look like clean streams," but which receive local pollution at various points, like the main stem of the Susquehanna and its North and West Branches, the Allegheny River from Warren down, and the Monongahela — are those for which 35 per cent or better removal of the raw BOD is the minimum requirement. These are minimum values. Only in the case of those streams which are so heavily polluted with acid mine drainage that treatment would not result in a commensurate public benefit will some treatment not be required. It all goes back to the particular waste you are dealing with. If you are dealing with cheese whey with, say, 30,000 or more parts per million of BOD and you take out 85 per cent by the so-called "complete treatment," and have 15 per cent left, just as in the case of distillery slops, you have a very high load remaining. If you are talking of phenols and you left 15 per cent in the waste waters, it might play "hob" with public water supplies by producing objectionable tastes and odors in such supplies. We can therefore only enunciate a policy and general types of treatment, but the orders will be specific for each particular community. The requirements as to degree of treatment can be rather readily stated because municipal sewage has rather well known characteristics, and the methods of treatment are well known. But when it comes to industrial wastes, we will in many cases have to give them detailed, individual study. In some cases it will mean working out the solution in cooperation with the industry.

L. V. Black: The subject of stream pollution and the clarification of stream waters is a matter of much interest to all industrial plants. When river water is used in the cooling systems for transformers, condensers, etc., it is only a question of time until he pipes and tubes become clogged with a sludge, which — aside from being a heat insulator — is very difficult and sometimes costly to remove.

Deep well or spring water, if lime free, can be used for these purposes; however the source of supply of such water is limited. All mill operating people certainly would appreciate an unlimited supply of good clean, cool river water.

J. E. Gold: We have heard the story about blocking up the service water pumps with clean water from the Schuylkill River at a nearby steel company. At Bethlehem we have not experienced that unusual condition, but due to blast furnace flue dirt in the Lehigh River water, combined with low seasonal flows of the river, the inlet channels to the service water pumps have been critically affected by the deposition of settleable solids.

The Lehigh River water, polluted in the past by blast furnace flue dirt, has been distributed to heat exchangers throughout the plant, resulting in costly outages and reduced performance.

The installation and operation of the clarifier system at Bethlehem has two outstanding features among the many. First, it has eliminated the pollution of the river with blast furnace flue dirt, which in turn has greatly reduced the dirt content of our plant service water. Secondly, the economic return on the clarifier system has exceeded our original estimates and represents a profitable operation, not only from the abatement of stream pollution but also from a production viewpoint.

I feel that many industries have overlooked the purification of their polluting waste waters on the grounds that such processes are just another expense to the product, but in many instances suitable purification or

recovery processes are definite assets in the final analyses.

To the Sanitary Water Board, we express our appreciation for the cooperative assistance in the development of the clarifier system, which is now returning our waste water to the river in practically the same condition as it is received.

G. T. Williams: Lake Michigan is a big lake with a lot of water, but at the lower end it has probably the highest concentration of industry that exists anywhere. It has on one side of it a large city, and there has been a lot of commotion about what kind of water Chicago gets out of Lake Michigan.

Recently, the First Industrial Waste Utilization Conference was held at Purdue University, under the direction of the School of Civil Engineering, the Department of Sanitary Engineering, and in cooperation with 15 groups of people, such as the State Board of Health, the Conservation Department, the State Chamber of Commerce, and about 12 trade associations. This group considered the disposal of all sorts of wastes. They had some formal papers with discussion periods, and then broke up into smaller groups, with one in particular on the subject of steel mill waste. Dr. Hodge led one of them and he had a formal paper on steel mill waste. I have heard him say that he knows of 39 different ways of disposing of pickling waste, none of which even come close to breaking even in cost. He has said that if he had some way of breaking even in removing the sulphuric acid waste, the steel industry would produce 14 times as much ferrous sulphate as the country normally uses.

Out of this came discussion with the operators of sewage disposal plants on the merits of ferrous sulphate in sewage disposal. There are two plants in the Chicago district, one at Evanston and one at Gary, where the ferrous sulphate (acid waste) is put into the sewage disposal plant because the operator of the sewage disposal plant wants it as a coagulant. Other operators say that they don't want the stuff near the plant and some thought it would be of value if fed to them at a uniform rate throughout the day and if it were neutralized to the point where you do not precipitate the iron salt, leaving the waste slightly on the acid side.

J. R. Hoffert: That is a very interesting point and it brings up a matter of which the lay public has little appreciation.

Mr. Williams stated that Dr. Hodges knows 39 ways of treating steel mill pickling liquor. I think he may know of even more, according to an early paper of his. And it is said none of them "broke even." I think that is true, but I think that it must be borne in mind that we must not necessarily "break even" to justify treatment; that we have a responsibility to meet, even though the value of a possible by-product doesn't equal the cost of treatment. And Dr. Hodges said that if he did have a method which would break even, he could produce 14 times the amount of copperas which the market could absorb.

That is about the same situation which the sulphite paper industry faces. You can make vanillin out of sulphite liquor and you can also make shoe polish and adhesive and a good many other things, but in a little plant in upper New York you could make as much of some of these products as the whole market could absorb. So that was no answer to the hundreds of thousands of gallons of sulphite waste liquor produced throughout this country in a day. But we have conservationists telling us that if we would just use the methods already known we could solve the problem of sulphite wastes at a profit. We who are concerned with administering stream pollution laws have so long been between the sincere but uninformed lay public opinion and the stubborn facts of what is theoretically or even technically possible but utterly impractical from an economic standpoint, that we expect criticism. We don't mind that, if one small plant can flood the available market and the rest of the product would have no outlet except to be dumped somewhere at an additional cost for disposal.

We all know that copperas, or sugar sulphate of iron, is a very effective coagulant, as are all iron salts of that type, whether chlorinated copperas or ferric or ferrous sulphate. They are all coagulants and their value is, in general, in proportion to their iron content. So they are useful and I was going to bring out the point that some sewage treatment plants have trucked the pickling liquors to the plant to use as a coagulant.

That, however, offers a limited market and those of you who are chemists know that many years ago the American Steel and Wire Company issued quite a useful booklet to prove that you could get rid of "red water" troubles in public water supplies by using iron salts instead of alum because you didn't produce acid water by the liberation of CO_2 as is the case when alum is used. There is some chemical basis for that contention and there is no question about the value of copperas as a coagulant within its proper field. But pickling liquor wastes cannot be dumped into the sewage system without causing trouble. One large sewage treatment plant in Ohio had a lot of trouble when a steel mill sent its pickling liquor down the city's sewer system. The crushed stone of the trickling filters was cemented into a solid mass as a result of the pickling liquors being oxidized in the filters.

R. J. Graham: Our problem at Johnstown has been for more than 50 years to keep the stream in its banks. We had a flood in 1889 and one in 1936, and the army engineers came in and we think we have it licked. But it is red. It runs red, and our plant stretches 8 miles along the creek. It is not only red but it is all hues of the rainbow with some of our lubricating oil. Mr. Hoffert's thought-provoking comments are very interesting, and I hope that we can lick our condition.

J. Hellman: One point is not quite clear to me. When you have a river that has an original BOD of 5, what is the allowable BOD load for that river?

A. J. Fisher: Our problem is the disposal of an effluent containing the wastes of sulphuric acid and oils. We are hoping for some collective solution to this problem before we will be required to try and solve it partially. We need help and would like to hear about any ways and means of doing this disposal job without pollution.

Wm. P. Hill: In the handling of water, you have two problems. Anyone can tell if they have good or bad water, but the trouble is to find out a satisfactory water — one on which every one will agree.

If you ask the State Board of Health what the BOD or suspended solids should be, nobody seems able to

tell you. If you ask a mill man what he wants for cooling rolls, what the chlorides should be, he wants it zero. Until we can arrive at what we want, your problem is not solved. I feel it is just an economical problem, as any water, providing the quantity is available, can meet any quality specifications if costs are not considered.

J. R. Hoffert: I was particularly interested in what my friend Mr. Bye had to say. He felt that the large industries could do much on this on their own account to find the answer to some of their problems, but that many of the small industries could not, and that there ought to be a solution by the industry as a whole. I think that is the proper approach to it. It is the approach which the Board has tried to use in more than one case and on more than one occasion.

It may be remembered that we had the Pennsylvania Tannery Waste Disposal Committee of Pennsylvania, composed of representatives from all the tanneries of the State and representatives of the Board. Out of that came the method which is approved for the treatment of tannery wastes and which incidentally provides for a first step, followed by higher degrees of treatment, as the requirements of a particular stream may make necessary.

We had a somewhat similar arrangement with the pulp and paper industry. There were a number of other industrial groups which cooperated with the Sanitary Water Board in the solution of their industrial waste problems. All of these have ceased to exist in their original form either because they attained their objective or because during a later administration they were felt to be a sop to the public and a disguised way of letting the industry go ahead and do nothing. That was not the case; considerable good was attained even though there may have been a little "tongue-in-cheek" attitude upon the part of some of the members of some of those committees.

But I do think the way to solve industrial waste problems is on the industry basis and that the big units of the industry should combine through their trade associations or groups with the smaller units of the industry and actively seek and find the answers.

Mr. Bye also spoke of the problem of congested areas, which is a very important and practical one. We have it in the case of the anthracite silt problem which we are facing now. It is a simple matter where you have a large area of settling ponds to clarify your water in a short time. If you have to go to some type of clarifier, where waste particles have a much greater distance to settle to get out of the outgoing water, the upward velocity becomes very critical and makes a great difference in the cost of treatment. The area that is available for installation is a very important matter.

Mr. Patin was very gracious in his remarks. He said that the Board had accepted what his company could do. That was not just a "gift" to the company but a realistic approach to the facts of the case. That problem involved a plant whose future was somewhat problematical as to whether or not it would be continued in operation or changed in character of product after the war.

The Board is interested in bringing the greatest good to the greatest number of people and it realizes that we are in a wartime era when things are abnormal. So the problem of Mr. Patin's plant was analyzed and a satisfactory solution from the public standpoint, we think, was worked out, whereby the wastes from the one plant were cared for completely while the wastes from the other plant were quite well cared for, leaving the treatment of the remaining part to be determined upon after the future of that plant becomes known.

Apropos of what Mr. Gould said on the subject, I would emphasize the benefit of the flue dust recovery plant in improving the process water of his company's Bethlehem plant. Before they put in the tray clarifiers, the process water for the plant as taken out of the Lehigh River contained 13 grains per gallon of suspended solids in the water the plant used and this amounted to some 145 tons a day. Since they have taken out the flue dust, the raw water contains only one grain per gallon. They fully appreciate that and feel that the improvement in their water supply alone was a very big benefit.

As to the meaning of BOD, it simply means biochemical oxygen demand. Organic materials require oxygen for their chemical breakdown and stabilization which is brought about by means of the bacteria which use this decomposible material in their metabolism or life processes. In other words, they feed on this organic matter but need oxygen to convert to their use. They take this oxygen from the stream to use, for instance, in converting the ammonia into nitrites and nitrates, thus breaking down the sewage into stable forms of material. So the BOD is a measure of the oxygen which the organic wastes are going to take out of the stream and it is measured by means of the bacteria themselves. If you have a sterile sewage you won't have any BOD because there are no "bugs" to break down the sewage and use oxygen in their processes of doing it. Thus, where you have wastes which contain substances inimical to the life process of the "bugs," the BOD may not be the proper criterion of their pollution load. BOD is one of the standard "yardsticks" but it isn't always the correct one and there are a lot of wastes which may have high oxygen-demanding properties but where we can't measure the demand by the usual BOD methods.

Mr. Hellman asked about the stream with five parts BOD — what was going to be required of his wastes. Perfectly clean stream water has a definite dissolved oxygen content varying from 9.17 parts per million at 68 F up to 14.6 at 0 F. Water will hold larger volumes of dissolved gas at lower temperatures, but bear in mind that at summer temperatures the water of a clean stream will contain only about 8 parts per million of oxygen. Therefore, if you have a BOD of 5 parts in the stream as it comes to you, you have residual value — a balance in the bank so to speak — of no more than 3 parts. That isn't a very good stream.

Mr. Williams commented on the concentration of industry in the Chicago area and about Lake Michigan. We know what that is, and we also know that Chicago is a great center of stockyards and that Bubbly Creek was so named because it was so septic it boiled. Chicago formerly disposed of its sewage without treatment by cutting through the divide between the Des Plains and the Chicago Rivers and transporting its sewage via diverted lake water to the Mississippi River. But after a while the U. S. War Department made the city put in sewage treatment works, and they have done some

outstanding work at Chicago and have wonderful plants out there. I hope they can do as much in the Youngstown district because we certainly do get from Ohio a stream that is a little too thin to plow and a little too stiff to flow through the pipes because of its heavy pollution load. Of course it does flow, but the Mahoning is one of the most highly polluted streams which we have.

And apropos of those remarks about the value to industry of clean waters, I think one of the best examples of that is in the Shenango River Valley. The water of the Shenango was reused so many times by the blast furnaces that the river water reached a temperature of 140 F in summer. The industries in the valley realized the value of clean water and contributed money to buy the land in Ohio needed for Pymatuning Reservoir, with the idea of storing clean water behind the dam to be let down to increase the low flows of the stream. That regulated discharge is of great value and you will notice that many of the dams which have been constructed in recent years are what are known as multiple purpose dams. They may be for power purposes, water supply, or low stream flow regulation or for all three purposes. By increasing the low flows they provide diluting water and consequently reduce the degree of treatment which would otherwise be required.

Reference was made to the red Conemaugh River. The army engineers have licked the flood problem and those who believe only what they see in the newspapers know that Johnstown has received many compliments that it has now been lifted out of the flood hazard class. We hope that it will some day be lifted out of the class of a red acid mine stream city, too.

HOWRY DISCUSSION

(*Continued from page 70*)

ject in the steel industry for a good many years — long before I became a steel man. Some time ago I investigated what had been done on it and found that it is a subject that, unless you have a system that is absolutely beyond fault, we had better leave it ungrounded. A grounded system would be ideal, but of course it means that on all motors and controls you would have to eliminate partial grounds that you find in almost all steel plants. As far as the operation of the plants with the grounded system, we find industries of all kinds use a grounded system.

The question was also asked about temperatures and heat given off by the rectifier. The rectifiers generate considerable heat. The tanks under normal load are about 50 C temperature. The closed water recirculating system will hold that temperature constant within three degrees, dissipating excess heat through the heat exchanger. You also have heat dissipation to the air. In warm weather, when cooling water is rather warm and the ambient temperature high, the operation gets critical. We have had the experience where the vacuum of the rectifiers had increased to the danger point; in other words, close to the tripping point. It was due, as far as we can determine, entirely to the high ambient temperature that the rectifiers were operating in. The rectifiers we bought were specified to operate at a 95 F cooling water temperature. As far as water is concerned, we are using city water on one unit and softened water on the other.

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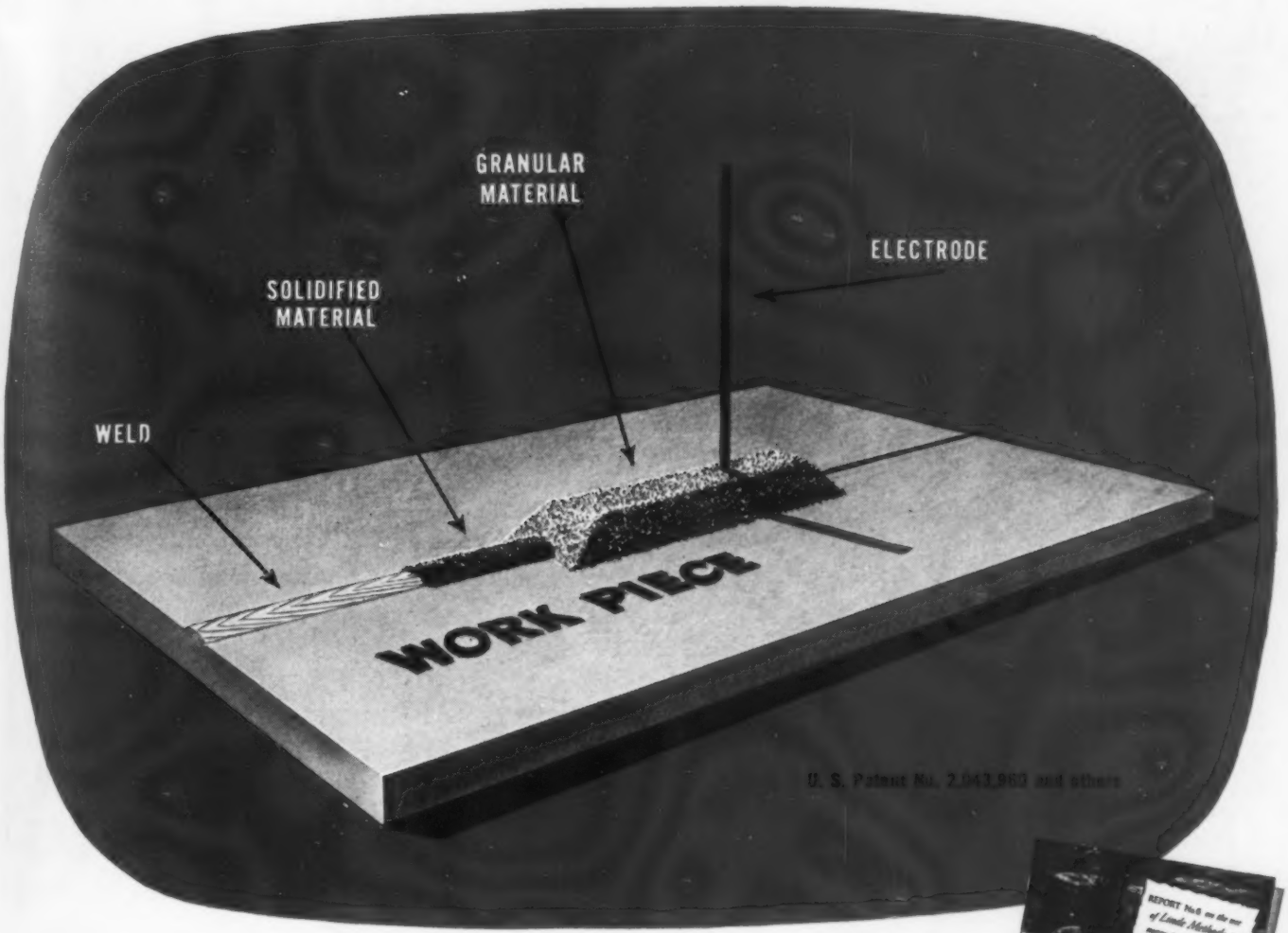
"MOTOR-DRIVE IS MORE THAN POWER"

THIS IS UNIONMELT WELDING

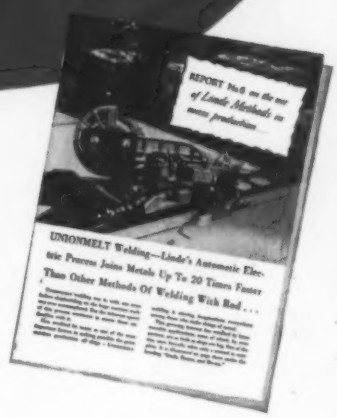


UNIONMELT Welding is easy to recognize. It is electric welding done as diagrammed above—and it makes top quality welds at speeds that are greater than with any other similarly applicable process!

UNIONMELT Welding, a process of welding electrically beneath a mineral melt, has received wide application since U. S. Patent No. 2,043,960 was issued. It is the electric welding process that is rated by many as one of the most important factors in the great wartime fabrication of steel.

Anyone may obtain a license to use UNIONMELT Welding through its developers—The Linde Air Products Company.

Linde can supply a wide variety of equipment and materials to apply UNIONMELT Welding. Linde representatives can help you determine where you can use the UNIONMELT process advantageously and what type of equipment is best suited to your work.


REPORT No. 6 on the use of Linde Methods in mass production
UNIONMELT Welding—Linde's Automatic Electric Process Joins Metals Up To 20 Times Faster Than Other Methods Of Welding With Rod . . .

For additional information send for the folder "Report No. 6 on the Use of Linde Methods in Mass Production."

MARITIME "M" AWARD FOR OUTSTANDING PRODUCTION ACHIEVEMENT

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

30 E. 42nd St., New York 17, N. Y. UCC Offices in Other Principal Cities

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The word "Unionmelt" is a registered trade-mark of The Linde Air Products Company.

★ BUY UNITED STATES WAR BONDS AND STAMPS ★

For Faster Bending and Straightening

BIRDSBORO HYDRAULIC

MODERN BIRDSBORO PRESS CAN FACILITATE THESE JOBS IN YOUR PLANT

You can facilitate your bending and straightening operations on this modern Birdsboro Hydraulic Press. The press as illustrated is equipped with horizontal and vertical rams, permitting bending and straightening to suit your requirements. The special design of the Birdsboro Hydraulic Press also permits setting up and removing work from either side, to further facilitate production.

Birdsboro Hydraulic Presses are designed and built to help make your pressing jobs as easy and as productive as possible. Our engineers work with you right from the start. Draw on our diversified press experience to get the individual type of hydraulic press that best meets your needs. Call Birdsboro today.

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8'—0" SQUARE
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350 TONS VERTICAL RAM
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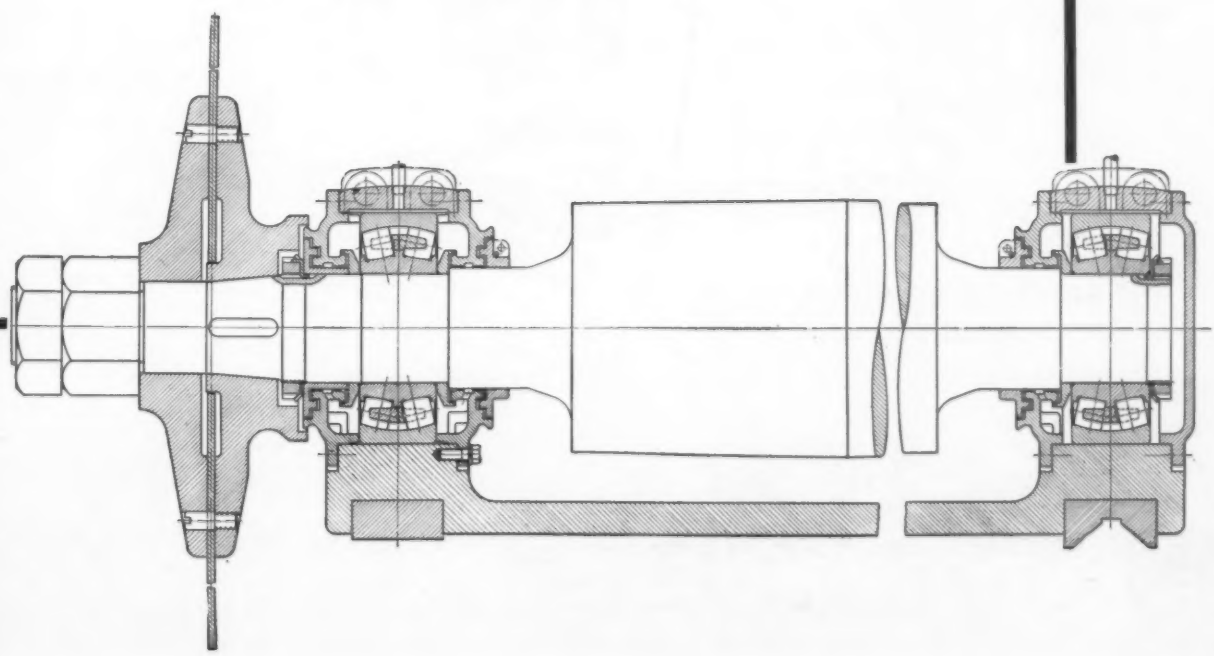
HYDRAULIC PRESSES

EASING HEAVY DUTY SAW OPERATION

The rolling alignment of SKF Spherical Roller Bearings plays an outstanding part in the smooth operation of high speed, heavy duty saws. It compensates for momentary deflections and prevents internal binding which would develop high frictional heat and complicate lubrication. It assures equalized load distribution . . . full bearing capacity available at all times. For information regarding all types of SKF applications in the Steel Industry, send for "Steel Mill Data for Calculation and Design." 5842

SKF INDUSTRIES, INC., FRONT ST. & ERIE AVE., PHILADELPHIA 34, PA.

SKF
ROLLER BEARINGS



25% SAVED

IN HOT-NUT FURNACES by B&W INSULATING FIREBRICK

A prominent steel company reports fuel consumption cut 25% after the installation of B&W K30 Insulating Firebrick in its hot-nut furnaces.

The average life of B&W I.F.B., used throughout the mill, is over five years. Thus the cost of the brick, on a service-life basis, is decidedly low.

Savings such as these are possible because, at the maximum service-temperatures for which they are recommended, B&W I.F.B. are lightest in weight, lowest in heat conductivity, possess high hot-load strength and show negligible permanent volume change.

Your local B&W representative will gladly tell you how you can save with B&W I.F.B.

THE BABCOCK & WILCOX CO.
Refractories Division
85 LIBERTY ST., NEW YORK 6, N. Y.

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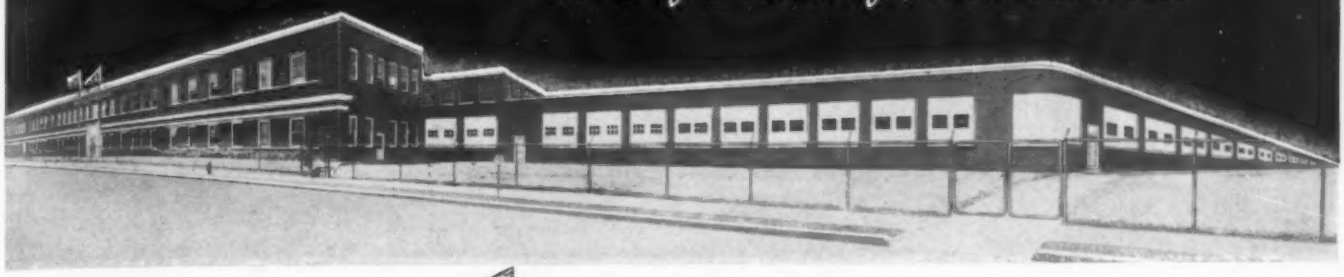
★ BUY WAR BONDS! BUY MORE THAN BEFORE ★

R-200

"3C" TAKES ON A NEW MEANING . . .
CAPACITY-CAPABILITY-CONTINUITY

(No. 3 of a series of Advertisements)



CONTINUITY

When you set out to buy electrical control you look for features that will assure:

1. **Long life for the control apparatus**
2. **Fewer production interruptions**
3. **Lower maintenance costs**
4. **Trouble-free operation**

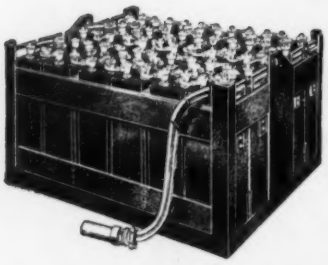
This is what we mean by CONTINUITY.

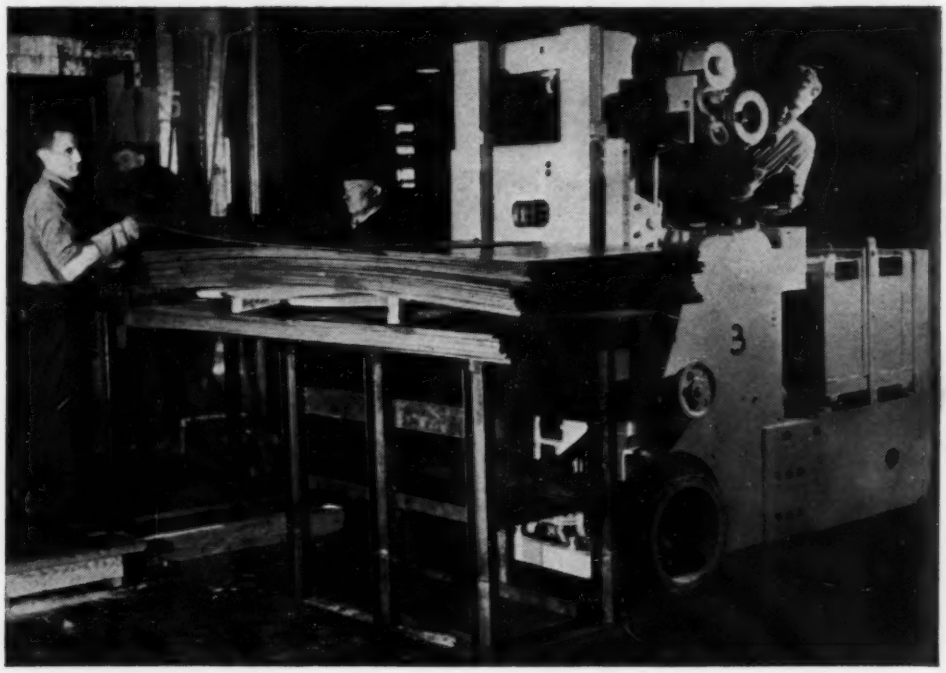
The Clark Controller Company puts into "3C" apparatus the experience of years, up-to-date-developments, engineering "know-how," highly trained personnel, to assure this CONTINUITY.

THE CLARK CONTROLLER CO.

1146 EAST 152nd ST., CLEVELAND 10, OHIO • EVERYTHING UNDER CONTROL

BATTERY TRUCKS keep machines busy...





...ALKALINE BATTERIES keep trucks on the GO

In Industrial Trucks, Alkaline Batteries Give You These Important Advantages

- They are **durable mechanically;** grids, containers and other structural parts of the cells are of steel; the alkaline electrolyte is a preservative of steel.
- They can be **charged rapidly;** gassing cannot dislodge the active materials.
- They **withstand temperature extremes;** are free from freezing hazard; are easily ventilated for rapid cooling.
- They are **foolproof electrically;** are not injured by short circuiting, reverse charging or similar accidents.
- They can **stand idle indefinitely** without injury. Merely discharge, short-circuit, and store in a clean, dry place.
- They are **simple and easy to maintain.**

Fast, steady and efficient movement of materials to and from machines, 24 hours a day, is one of the important ways battery industrial trucks are helping to speed production, save man-time and cut handling costs in all kinds of busy plants. A continuous flow of materials in process is maintained without interference to machine operations. Work is spotted in the most convenient and accessible locations for feeding each machine with the least manual handling.

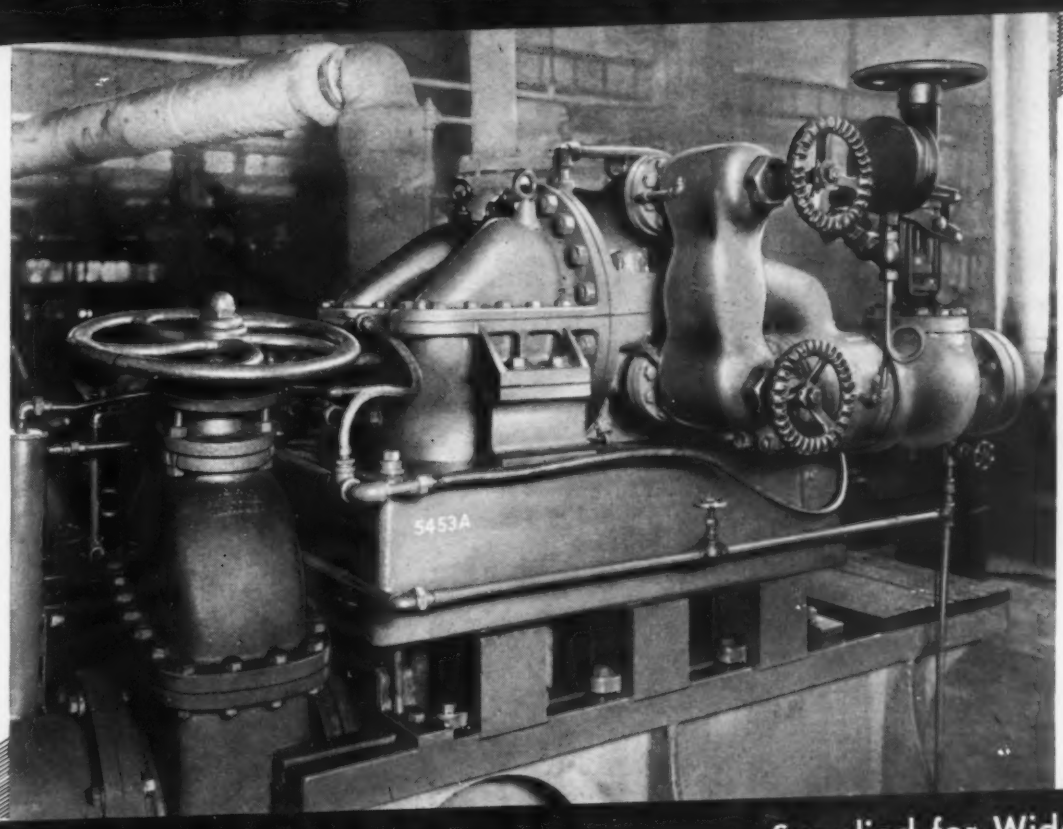
Keeping machines busy on round-the-clock schedules is a continuous stop-and-go handling job in which the battery industrial truck excels because of its inherent flexibility, high availability and economy.

Exchange batteries keep the truck continuously supplied with power. While one battery operates the truck, another is being charged. Except for the few minutes needed to change batteries, the truck need not stop for servicing its power unit. Its electric motor drives have a minimum of wearing parts; are inherently simple and trouble-free. The truck starts instantly; accelerates smoothly; operates quickly; gives off no fumes; consumes no power during stops. Not only does it make efficient use of power but the current used for battery charging is the lowest cost power available.

Altogether, the battery industrial truck is one of the most dependable and economical types of handling equipment—especially when powered by Edison Alkaline Batteries. With steel cell construction, a solution that is a preservative of steel, and a fool-proof electrochemical principle of operation, they are the most durable, longest lived and most trouble-free of all batteries. Edison Storage Battery Division of Thomas A. Edison, Incorporated, West Orange, N. J.

Edison
ALKALINE BATTERIES

THIS DE LAVAL UNIT COMPRESSES S-T-E-A-M



OTHER DE LAVAL COMPRESSORS Supplied for Wide Variety of Services

The above single-shaft, two-bearing steam turbine-driven compressor, operating at 25,000 r.p.m., compresses steam from 375 psi to 600 psi at a rate of 18,000 pounds per hour.

For services requiring increased steam pressure, when boilers for generating such pressure are not available, centrifugal compressors can be used to provide the increased pressure where the volume is sufficient.

De Laval builds centrifugal blowers and compressors for handling air, steam and other gases for a range of volumes up to and above 100,000 c.f.m., and for pressures up to and above 100 pounds per square inch, the maximum economical pressure depending upon the inlet volume and density.

De Laval compressor and blower specialists will gladly confer with you on any gas handling problems you may have.

3828

TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS CENTRIFUGAL PUMPS • CENTRIFUGAL BLOWERS and COMPRESSORS • IMO OIL PUMPS

DE LAVAL

STEAM TURBINE COMPANY · TRENTON 2, NEW JERSEY

SALES OFFICES: ATLANTA • BOSTON • CHARLOTTE • CHICAGO • CLEVELAND • DENVER DETROIT • DULUTH • EDMONTON • GREAT FALLS • HAVANA • HELENA • HOUSTON KANSAS CITY • LOS ANGELES • MONTREAL NEW ORLEANS • NEW YORK • PHILADELPHIA PITTSBURGH • ROCHESTER • ST. PAUL • SALT LAKE CITY • SAN FRANCISCO • SEATTLE TORONTO • TULSA • VANCOUVER • WASHINGTON, D. C. • WINNIPEG

SELF CONTAINED 2300 VOLT OIL IMMERSED A.C. INDUCTION MOTOR CONTROL

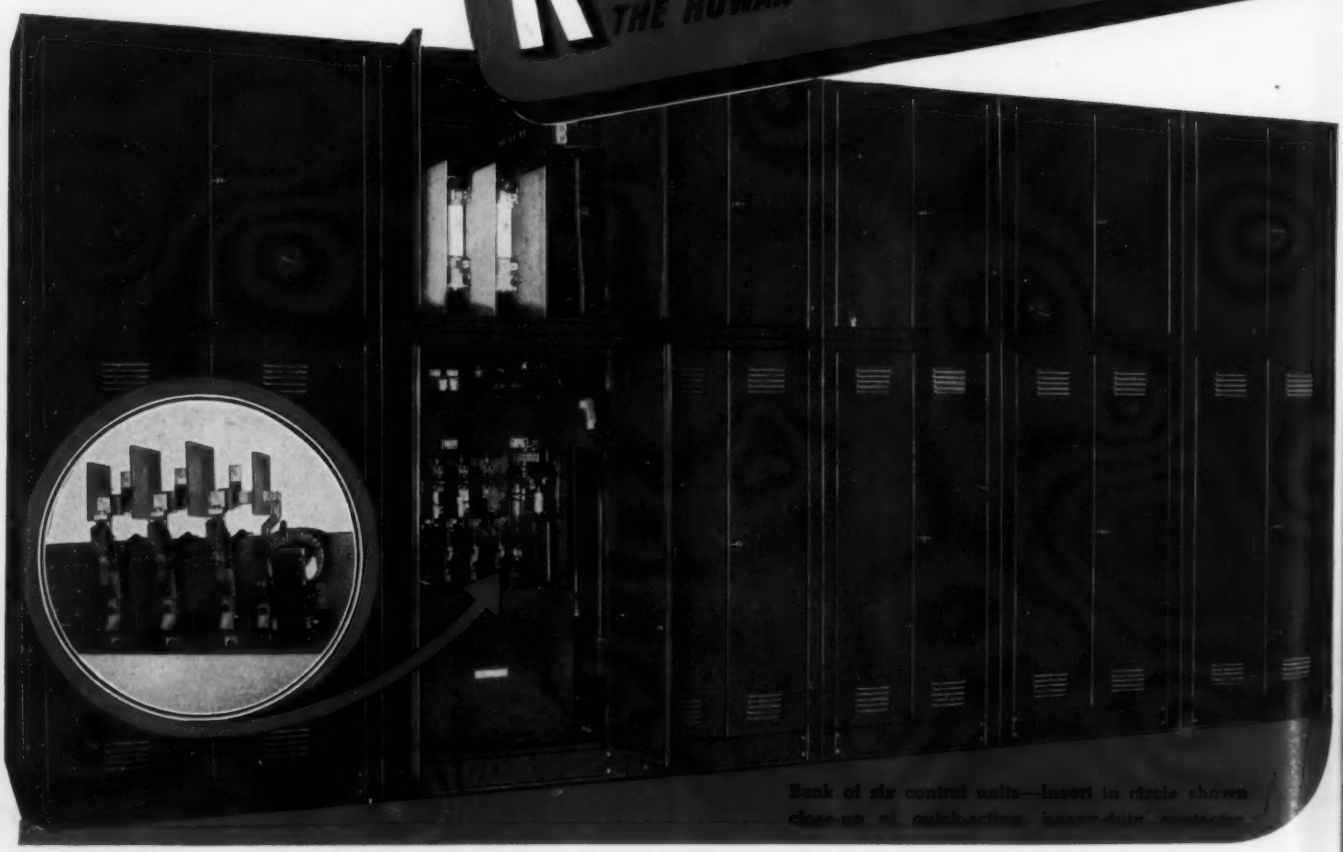
CONSTRUCTION AND OPERATING FEATURES

1. They have an especially designed, quick-acting, heavy-duty contactor.
2. High interrupting disconnect fuses, hook stick operated.
3. Self-contained, seal-off motor terminal compartment.
4. Centralized self-contained low voltage control terminal compartment.
5. Magnetic overload relays with electric reset, instantaneous and inverse time element.
6. Self-contained control potential transformer.
7. Self-contained Tank lowering device.
8. Insulated Bus, supported on porcelain Insulators.

The simplicity, efficiency, and flexibility of this Push Button operated Control have been made possible by Rowan Engineers after thirteen years of research, and production of this type of equipment. It has been designed for Engineers whose prime thoughts are safety, continuous operation, minimum installation and maintenance cost. These starters are floor mounted and are arranged for single or group installation. They are Push Button operated; of the full voltage or reduced voltage type; arranged for indoor, or outdoor service; are of cubicle construction and are complete within themselves. *Let us have your 2300 Volt control problems.*

ROWAN CONTROL

THE ROWAN CONTROLLER CO., BALTIMORE, MD.



Bank of six control units—Insert in circle shows close-up of quick-acting, heavy-duty contactor

For Your
TECHNICAL LIBRARY

This series of Askania Bulletins describes *in detail* the many ways in which automatic control is applied to Flow, Pressure, and Ratio problems in steel mills. Any one or the entire series is yours for the asking. Why not check the list below and send in your request today?

100—PRESSURE CONTROL
101—RATIO CONTROL
104—SPECIALIZED APPLICATIONS
105—UNIT REGULATOR
111—TRANSOMETER
112—HYDRAULIC STABILIZER
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115—OPEN HEARTH FURNACE CONTROL
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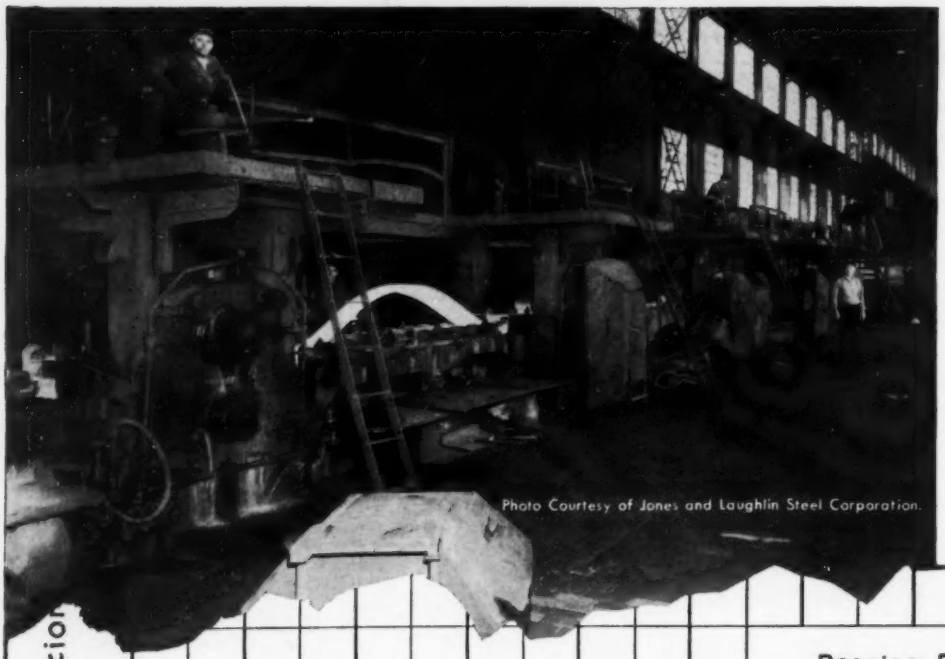
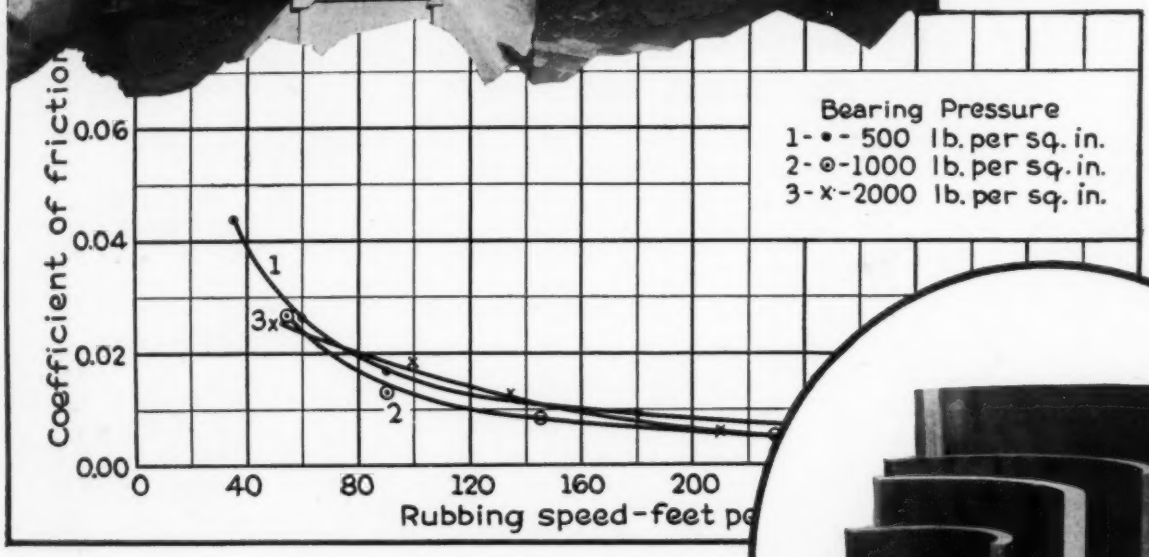
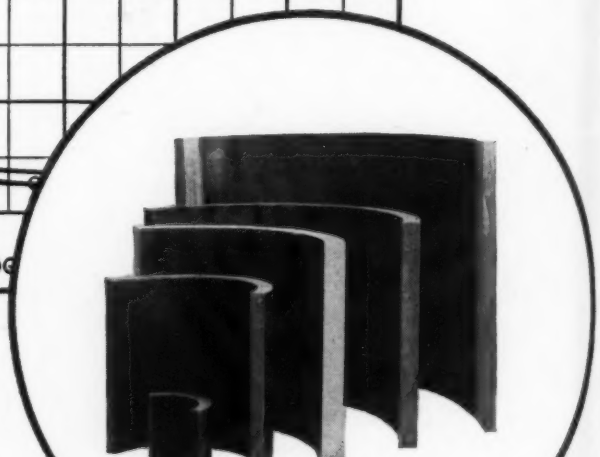


Photo Courtesy of Jones and Laughlin Steel Corporation.





Jones and Laughlin Steel Corporation Uses G-E Roll-Neck Bearings

Jones and Laughlin Steel Corporation's 30″ Hot Strip mill in Cleveland, Ohio, uses G-E Textolite roll-neck bearings because of their economy.

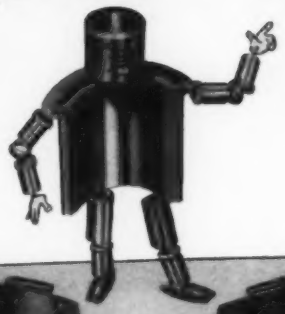
Simple water lubrication reduces material and labor costs, provides a cleaner operation. Low friction losses mean power economy; keep necks cool preventing fire cracks. Increased life minimizes number of bearing changes and adjustments—cuts down-time. For further information write section W-70, One Plastics Avenue, Pittsfield, Mass.

Hear the General Electric Radio Programs: "The G-E All-Girl Orchestra," Sunday 10 P.M. EWT, NBC. "The World Today" news every weekday 6:45 P.M. EWT, CBS. "G-E House Party" every weekday 4:00 P.M. EWT, CBS.

GENERAL ELECTRIC PD-70

Buy and Save War Bonds

How GATKE BEARINGS Help SPEED STEEL PRODUCTION



GATKE Self-Alyn Slipper Bearings typify GATKE development ingenuity, as well as the marvelous resistance to shock and wear afforded by GATKE Moulded Fabric Bearing Materials.

On Universal Couplings of all types and sizes GATKE Slippers give ten times more service than bronze. Eliminate scoring and wear to sockets and spades. Stop severe pounding, vibration and deafening noises. Facilitate proper lubrication and avoid grease slinging.

They are moulded to finished dimensions for replacing ordinary Slippers without machine shop work.

Tremendous Wear Life—Reduces replacement delays and bearing maintenance 90% and more.

Accurate Holding of Gauge—Maintains close tolerances—avoids screw down delays and minimizes "off section" losses.

Eliminate Hot Necks—No waiting for necks to cool. No premature neck breakage due to heat checking.

Lowest Friction—Permits heavier reduction per pass.

Furnished Ready to Install—No machine shop work required.

Through savings of power, maintenance, and grease, GATKE Bearings *contribute mightily to the War Effort.* They are moulded to machined accuracy for replacing metal bearings quickly and at insignificant cost.

Whatever your service send specifications covering the application for Facts and Figures.

The great economies of GATKE Bearings are not limited to Roll Necks. They are giving wonderful results on Spindle Carriers, Table Rolls, Guide Rolls, Conveyors, Cranes and other troublesome applications.

Write for descriptive bulletin showing performance results on typical applications, covering a wide range of service requirements.

Other GATKE PRODUCTS

Brake Lining
Clutch Facings
Friction Blocks
Silent Gears
Pump Valves
Piston Rings
Sheet Packings

GATKE CORPORATION 228 N. LaSalle St., CHICAGO 1,

NON-METALLIC MOULDED FABRIC **Gatke Bearings**

For Roll Necks, Universal Couplings, Spindle Carriers, Table Rolls, Cranes, Acid Resisting Service, and Other Tough Jobs.

HOW DO YOU SHOCKPROOF A MILL DRIVE AND PINION STAND?

FARREL-BIRMINGHAM mill drives and pinion stands are made shockproof by fitting the design, proportions and materials to the job the units have to do. This means that each drive unit is the result of a careful engineering study and that every vital part is of a size and material which provides fully adequate strength to meet continuously the particular stresses, strains and shock loads to be encountered.

Housings are of cast steel, Meehanite or welded steel construction with either double-walled or single-walled deep base, depending on rigidity requirements. They are proportioned to bear the brunt of continued strain and stress and yet maintain accurate alignment of all shafts.

The gears and pinions are usually continuous tooth herringbone—the famous Farrel-Sykes *Gear with a Backbone,* though other types of gears and pinions can be furnished. *Backbone,* the place where the teeth meet instead of being separated by a center groove, provides extra strength and load-carrying capacity.

Bearings may be either babbitt-lined steel cartridges or any approved make of anti-friction bearing — always of adequate size for the job they have to do.

The precision ground shafts are designed to provide the rigidity necessary to prevent deflection and keep gears in exact alignment.

Dependent on conditions or requirements, lubrication may be by dip-and-splash system, by built-in pump driven by one of the shafts or by a separate lubrication system.

Our engineers will be glad to discuss gear drive problems with you at any time — without obligation.

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.

Plants: Ansonia, Derby and Stonington, Conn., Buffalo, N. Y.

Sales Offices: Ansonia, Buffalo, New York, Pittsburgh, Akron, Los Angeles, Tulsa, Houston, Charlotte

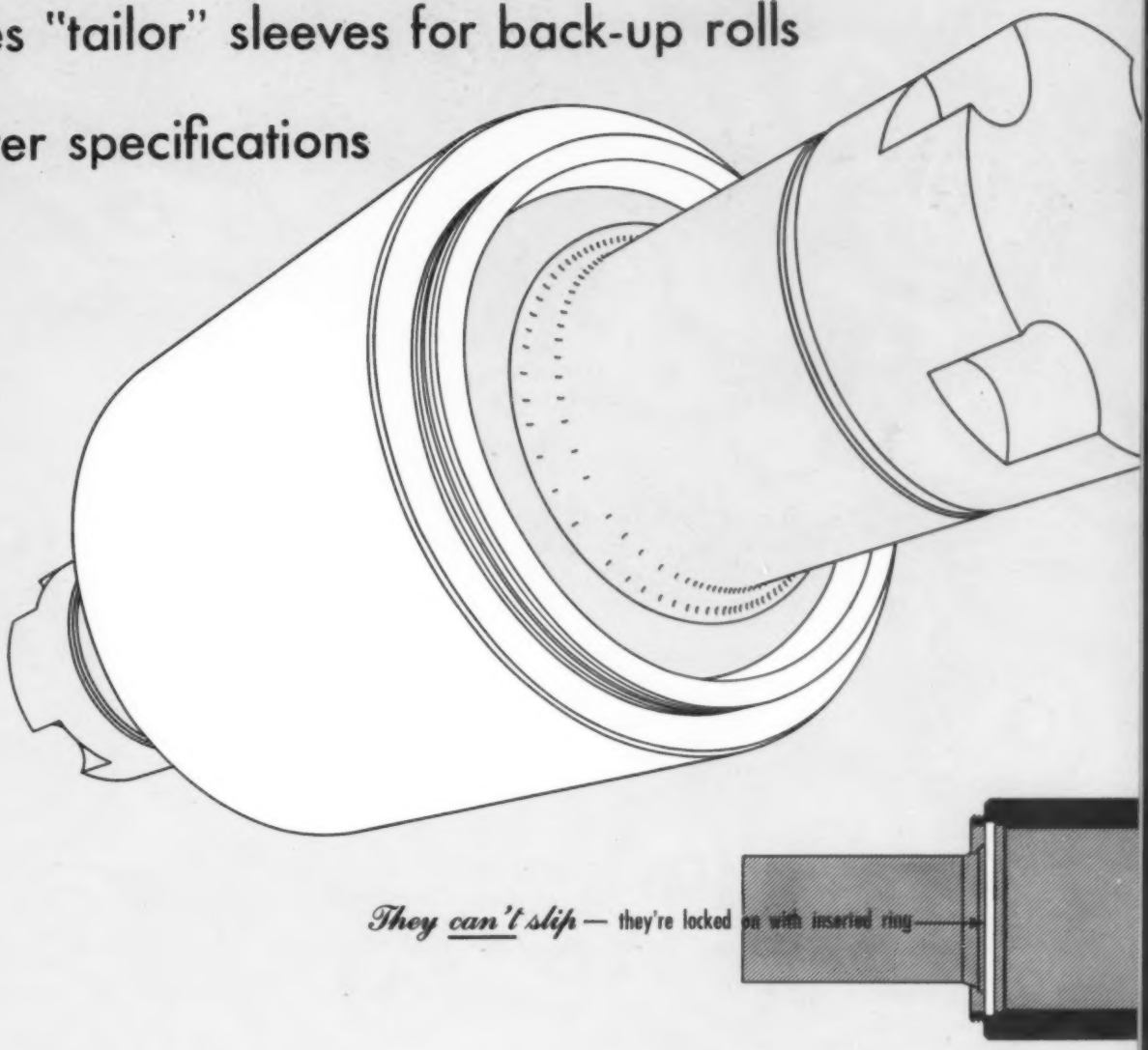
FB 222

FARREL ROLLING MILL MACHINERY

- Rolls
- Rolling Mills
- Rod Mill Tables and Manipulating Equipment
- Universal Mill Spindles
- Rod Coilers
- Gears
- Gear Drives of any Capacity
- Mill Pinions
- Pinion Stands
- Flexible Couplings
- Roll Grinding Machines
- Roll Calipers
- Lead Presses for Pipe or Rod

FARREL *Farrel-Birmingham*

Because **HEPPENSTALL** can and does "tailor" sleeves for back-up rolls to tighter specifications

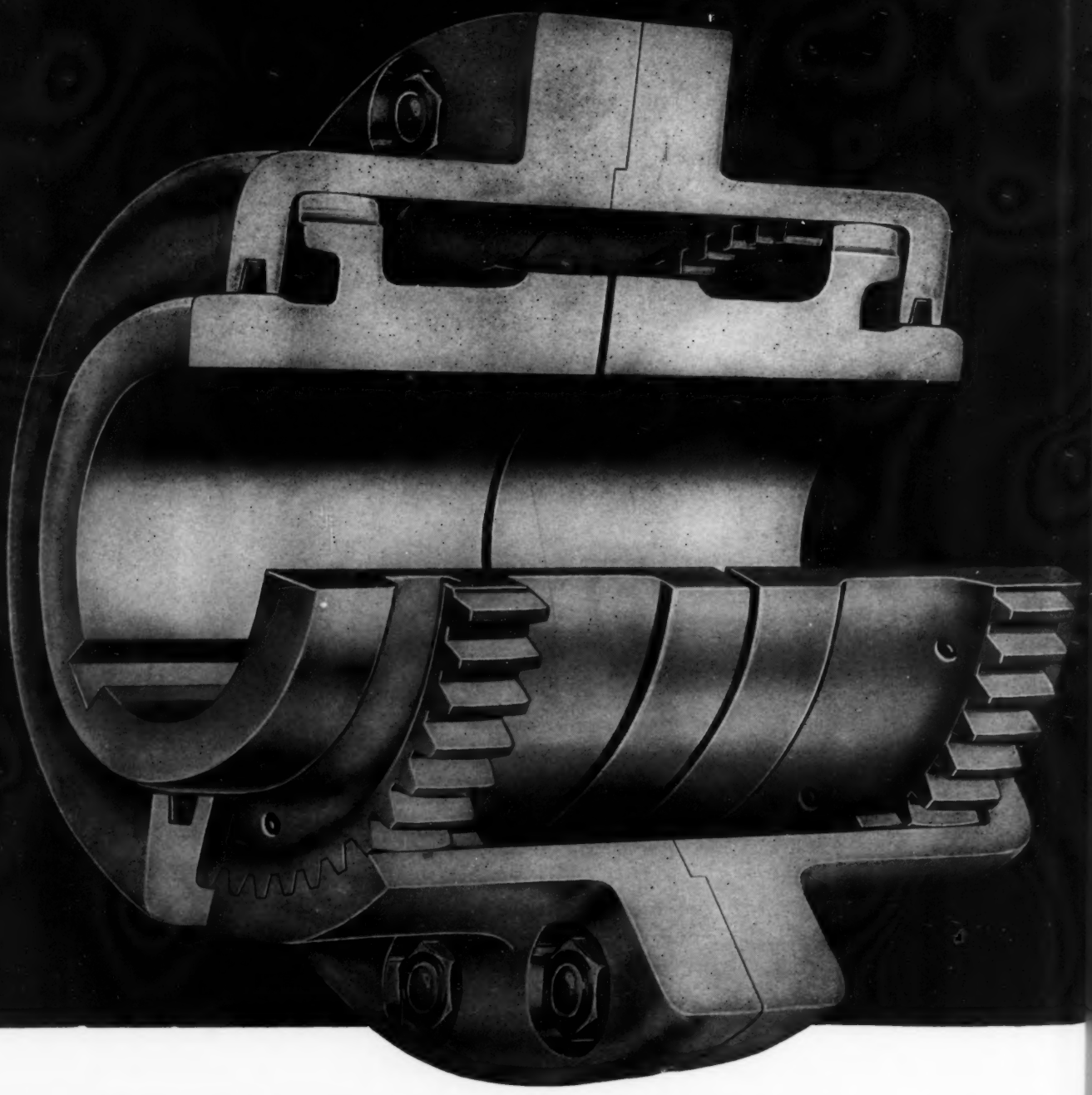


Here's one *definite* answer to reduced strip costs—Heppenstall back-up roll sleeves. Being a relatively small mass of metal with no necessity for the usual compromise between strength of necks and hardness of surface, these sleeves permit the incorporation of all Heppenstall's skill in metallurgy, forging and heat treating . . . and they can be furnished in any workable degree of hardness desired.

In all other respects, these sleeves are the *proved* equivalent of a solid roll *except*—they cost less, they last longer, and they eliminate the expense of scrapping a worn roll. If you would like to check their 15-year record of actual service in leading U.S. mills, write Heppenstall Co., Pittsburgh 1, Pa.

HEPPENSTALL, *The most dependable name in forgings*

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD

SOMETHING NEW IN HIGH PRESSURE AIR DELIVERY

These new Buffalo Centrifugal Compressors give up to 4 lbs. pressure per square inch in a single stage. Because each unit is designed to fit the exact operating conditions, peak efficiency at that condition is practical.

For handling air to oil or gas furnaces, on high pressure installations in glass, steel and chemical plants, for scale and water blowoff problems and all kinds of experimental work Buffalo Centrifugal Compressors offer unusually low-cost, high-pressure air.

Welded steel or alloy rotors used were developed as a result of tests in the Buffalo Vacuum Test Pit. If you have use for high pressure air, why not write today for Bulletin 3553 which describes these units.

Buffalo Forge Company
173 Mortimer Street Buffalo, N. Y.
Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo" "First For Fans"

CENTRIFUGAL COMPRESSORS

Continuous Pickling IN COILS

Makers of strip steel will find that this new method of continuous pickling in coils produces highest quality strip. Also, it saves space, saves money and saves time.

Sole Licensee

THE ARMS-FRANKLIN CORPORATION

Engineers and Builders of Rolling Mill Machinery

YOUNGSTOWN 3, OHIO

NEWS SUPPLEMENT July, 1945

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Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

UNITED STATES STEEL CORPORATION ANNOUNCES SEVERAL CONSTRUCTION PROJECTS

▲ Two large-scale projects of a program to meet postwar requirements for efficient facilities and quality products were announced recently by J. L. Perry, president of Carnegie-Illinois Steel Corporation. These projects are a continuation of the modernization and improvement program carried on by United States Steel subsidiaries during the pre-war depression years. Date of completion will depend upon availability of materials and labor.

Mr. Perry disclosed that Carnegie-Illinois will embark upon a program to increase its capacity for cold reduced tin plate products in the Pittsburgh and Chicago areas by a total of 233,000 tons annually. Carnegie-Illinois also will rebuild and enlarge one blast furnace at Gary, Indiana, and two at South Chicago, Illinois; and will replace ore and coke pockets at South Chicago furnaces. After rebuilding, these blast furnaces will be the largest in the country.

In the Pittsburgh district the cold reduced tin plate capacity of Irvin Works will be increased by approximately 129,000 tons annually.

In the Chicago district, the cold reduced tin plate capacity will be increased approximately 104,000 tons annually by the installation of new equipment at the Gary Sheet and Tin Mill.

This new tin plate improvement program is a continuation of the pre-war trend toward improved facilities to meet the change in trade demands from the old style hot reduced to the more modern cold reduced product, and is expected to help this United States Steel subsidiary more adequately meet the needs of tin plate users in the postwar period.

At Gary Works, No. 6 blast furnace will be rebuilt and enlarged from a daily rated capacity of 870 tons to 1,508 tons per day. The rebuilding will include new stoves, additional gas washing capacity, and other auxiliaries for the larger furnace, as well as a belt conveyor coke handling system and other stockhouse, iron and cinder handling equipment. No. 6 blast furnace was built in 1910 and last completely relined in 1928.

At the South Chicago plant, blast furnaces No. 7 and 9 will be completely rebuilt and enlarged and ore and coke pockets at blast furnaces 5 to 10 will be replaced. No. 7 furnace, built in 1910, has a rated capacity of 676 tons per day and was last completely relined in 1922. It has not been operating since July 3, 1944. No. 9 furnace, built in 1909, has a rated capacity of 713 tons per day and was last completely relined in 1930. It is expected to continue in operation until September 1, 1945. After rebuilding, each of these furnaces will

CONVEYOR BELT FOR LONG LIFT IN IRON ORE MINE

The greatest vertical lift of any single conveyor belt in the world is located in the Missabe mountain pit of the Charleston Iron Mining Company in northern Minnesota.

Total length 1900 feet, the belt of the cord construction type was manufactured by The B. F. Goodrich Company. It supplanted a three-belt system, handled 1,250,000 long tons of ore in the first year of operation and annually saves $15,000 in transfer and maintenance costs required by the previous installation.

The belt is a 30 inch, eight ply GR-S synthetic cord construction with ¼ inch top, including Transcord breaker and 1/16 inch back cover. Center to center distance is 947 feet, the total lift 272 feet, incline 35.53 per cent grade, speed 578 fpm, handles 550 tons per hr of wet or dry ore, has V-flat lagged snub drive with 257 degree arc of contact on 49 inch head pulley and 36 inch snub pulley. The tail pulley is 42 inches.

5 Reasons Why . . .

SCHLOEMANN "Motor-Rollers" are superior

1. Dependable performance
2. Flexibility of operation
3. Simple mechanical and electrical design
4. Accessibility around tables
5. Low maintenance costs

★ Schloemann installations are specifically engineered and designed for your particular requirements. Let our engineering staff help you.

Hydraulic Presses
Rolling Mill Equipment
Air-Hydraulic Accumulators
Engineering of Complete Hydraulic Systems
Extrusion Presses

SCHLOEMANN
ENGINEERING CORPORATION
1102 EMPIRE BUILDING . . . . . PITTSBURGH 22, PA.
HYDRAULIC PRESSES • ROLLING MILL MACHINERY

have a daily rated capacity of 1,508 tons.

At the same time, a new improvement program to meet increased postwar demands for cold reduced tin plate product was announced by Robert Gregg, president of the Tennessee Coal, Iron and Railroad Company. The project contemplates an increase in tin plate capacity in the Fairfield tin plate mill and the installation of feeders and cleaners for 28 tin stacks. The increase in capacity will be approximately 52,000 tons annually.

This new improvement program is a continuation of the pre-war trend toward improved facilities to meet the change in trade demands from the old style hot reduced to the more modern cold reduced product and is expected to help this United States Steel subsidiary more adequately meet the needs of tin plate users in the postwar period.

OIL ADDITIVE IMPROVES DIESEL ENGINE OPERATION

▲ The Hood Refining Company, 195 N. Hamilton Avenue, Greensburg, Pa., recently announced the addition of Gibraltar diesel fuel oil concentrate to their line of special oils and greases for industrial and commercial uses. Especially prepared as an additive to diesel fuel oils, (4 ounces to each 10 gallons of regular diesel fuel oil) the new concentrate prevents the corroding and sticking of injector nozzles, and at the same time gives top cylinder lubrication where ordinary oil fails, thus preventing the formation of hard carbon and sticking rings.

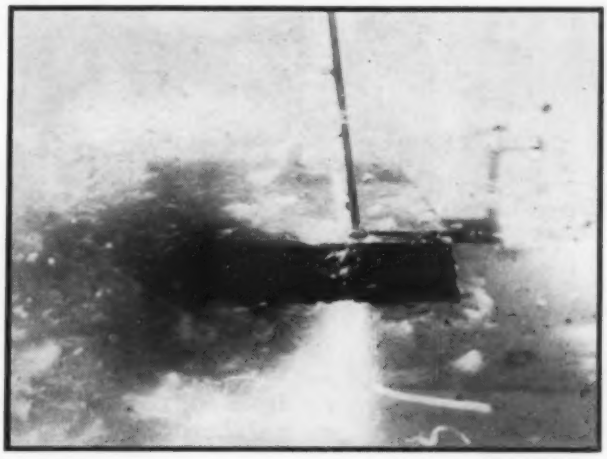
Gibraltar diesel fuel oil concentrate gives instant overhead lubrication where the ordinary oil system does not reach. It penetrates the pores of the metal, and in addition to giving proper lubrication, prevents hard carbon from adhering to the metal surface. Any carbon which is formed will be soft, and because the metal pores are impregnated with oil capable of withstanding high temperatures, the carbon will be expelled from the engine through the ports.

The concentrate is manufactured from a light mineral oil base, processed under a secret formula. It will mix thoroughly without agitation with any regular type fuel oil.

ELECTRODES FOR CUTTING, WELDING UNDER WATER

▲ Arc-oxygen underwater cutting electrodes, until recently manufactured by the Metal and Thermit Corporation solely for war purposes are now commercially available, the company announces.

The arc-oxygen electrode, developed from two independent steel cutting operations, utilizes the heating properties of an arc flame, ranging from 6,000 to 10,000F, for underwater kindling of steel plate and beams to the burning point. Into the molten steel thus produced, a jet of pure oxygen is produced to cut cleanly through the steel.



Steel cutting under water, using an electric arc for heating and an oxygen jet for burning the molten steel.

The electrode, information about which has until recently been restricted, has made possible the amazing speed with which invasion harbors have been cleared of sunken ships by Navy Salvage and Seabee Forces, and has permitted the underwater trimming and welding of ragged shell and torpedo holes in vessels afloat, enabling them to proceed to drydock for permanent repairs. So fast is the underwater cutting process that half-inch steel plate underwater, for instance, has been cut at the astounding rate of 52 inches a minute.

An underwater welding electrode, known as Murex type C-W, is also supplied in ⅛ in. to ¼ in. sizes. For general salvage operations the 3/16 in. size is by far the most widely used and is employed for welding plate from ⅛ in. to heavier thicknesses. The Murex C-W electrode also can be used effectively for cutting material up to ¼ in. in thickness.

For cutting heavier steel, the Murex C-T tubular electrode is employed. This is supplied in one size only, 5/16 in. outside diameter and .112 in. plus or minus .008 inside diameter. When in use, oxygen is passed through the opening in the tubular electrode. This method of cutting is faster and less hazardous than any other known method of underwater cutting. Both the Murex C-W and C-T electrodes have extruded and waterproofed coatings and are ready for use. Changing of the electrode can be easily accomplished under water.

In tests, the Murex type C-T tubular electrode shows average underwater cutting speeds ranging from 12 to 15 inches per minute for 1½ in. steel plate to 30 in. per minute for ¼ in. steel plate. The maximum underwater cutting speed ranges from 36 in. for 1 in. steel plate to 62 in. per minute for ¼ in. plate.

The tubular steel electrode may also be employed for cutting nonferrous metals and iron. It may likewise be used in the open air for the cutting of difficult high alloy steels, such as austenitic stainless.

NEW HOIST DRIVE FOR ACCURATE OPERATION

▲ A new hoist drive for cranes, known as the Maxspeed system, has been announced by the Industrial Engineering Division of the General Electric Company. The new drive, which automatically "measures" the load so that it is hoisted and lowered at the maximum safe speed yet prevents the handling of dangerous overloads, is designed for use on either indoor overhead, slow-speed cranes, or high-speed cranes of the type used in outdoor construction. The drive is particularly desirable for use on these cranes where accurate hoisting and lowering operation is of utmost importance.

The drive operates from either a-c or d-c incoming power. If used with a-c, the drive consists of a generator, an unusually constructed cross-flux exciter, an ordinary constant-voltage exciter — all driven by an induction motor, and a d-c hoist motor similar to the type used in crane-hoist installations except that its main field is designed for a variable separate excitation. If used with d-c, a shunt-wound d-c motor drives the generator and cross-flux exciter instead of an induction motor, and the constant-voltage exciter may be eliminated. Regardless of the type of power used, it is the special construction of the cross-flux exciter and the way in which it is connected to the other components of the drive that produces the unusual characteristics.

In operation, heavy loads are both hoisted and lowered at slow speeds, and light loads or the empty hook are hoisted and lowered at high speeds. Intermediate loads are handled at intermediate speeds, depending on the weight of the load. These speed changes are inherent in the drive and do not depend on the functioning of the control devices. All braking is accomplished electrically, the power being returned to the supply system instead of being dissipated in resistors. A solenoid brake holds the load when at rest.

JESSOP ORDERS NEW REVERSING COLD MILL

▲ Jessop Steel Company, Washington, Pennsylvania, has placed an order for a 19½ in. Sendzimir reversing cold strip mill under license agreement with the Armzen Company, Middletown, Ohio.

The new mill will have a capacity of 6,000 tons annually and will be used primarily for cold rolling solid and composite stainless and other alloy steels. The mill is a recent development in cold reduction and will increase the company's production, enabling them to help meet requirements for cold rolled specialties used in war equipment and industrial, commercial, architectural, and domestic applications.

The new mill is being constructed by the Waterbury-Farrell Foundry and Machine Company at Waterbury, Connecticut.

RELAY ANNOUNCED FOR GENERAL CONTROL USES

▲ For use in relaying the output of electronic apparatus, instruments such as pyrometers, etc. and for general control functions, the Electric Controller and Manufacturing Company of Cleveland 4, Ohio announce the new EC&M type WT relay for both a-c and d-c service.

Of double pole design and with poles electrically insulated on the moving arm, a wide selection of circuits are made possible. On alternating current, relays are available with single pole auxiliary contacts of normally-open, double-break design.

Main contacts are rated at 10 amperes, 300 volts and may also be used on circuits up to 600 volts under certain conditions. Contacts are silver to silver, including the auxiliary contacts on a-c relays.

The relay is mounted on a thick moulded base for direct mounting on metal bases. Front connected relays are standard. Optional rear-connected relays are furnished with stands extended through the back of the base.

NOVEL METHOD SPEEDS TAP CARBON ANALYSIS

▲ Tap carbon analysis has been speeded up considerably at National Tube Company's National Works by a novel sampling procedure now in standard use at several United States Steel Corporation subsidiary plants. The procedure consists of taking a test spoonful of slag-free metal from the bath, killing the steel with aluminum wire and drawing a column of approximately 6 inches of clean steel up into a 6 mm pyrex glass tube by means of a 1 ounce rubber bulb. Caution must be exercised to assure that no slag covers the surface from which the sample is drawn and that no time is lost between withdrawing the spoon from the bath and taking the glass tube sample. The sample is quenched in water, the glass broken from the steel and a test piece three-quarters of an inch long sheared from the center of the rod by wire clippers. This test piece is weighed directly and fused under standard conditions in a high temperature combustion furnace for carbon determination. The entire process requires approximately 12 minutes.

White 'hot' steel in a glass tube saves valuable furnace time in preparing a slag-free sample for carbon analysis at National Works, National Tube Company.

The test piece is ideal for carbon analysis since it is free from scale, segregation, and pipe. Experience with the new test shows a substantial saving in furnace time after a heat has been "blocked" and an improvement in the control of ladle carbon analysis. Patent applications have been filed covering the new test and procedure.

THOMAS
Flexible COUPLINGS

Eliminate BACKLASH, FRICTION, WEAR AND CROSS-PULL
the four destructive evils of other types and makes of couplings that prevent a permanent care-free installation.

The Thomas All-Metal Coupling has:
No Chains, No Gears, No Rubber.
No Lubrication Required

WRITE FOR COMPLETE ENGINEERING CATALOG

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA

BUFFALO PLANT ACQUIRED BY BLAW-KNOX COMPANY

▲ The plant, inventory and uncompleted contracts of the Buffalo Foundry and Machine Company, of Buffalo, have been purchased by the Blaw-Knox Company, Pittsburgh, Pennsylvania. The newly acquired property will be known as the Buflovak Division of the Blaw-Knox Company. No changes will be made in either management or personnel.

The Buffalo property includes an 18-acre site on which are located plants containing a plate fabricating shop, machine shop, foundry, pattern shop, and a well-equipped research and demonstration laboratory. According to William P. Witherow, president of Blaw-Knox, the acquisition is a further effort to strengthen the company's postwar position in the food, process, and chemical equipment industries — markets characterized by great advance in the past few years and ones which promise unusual postwar activity.

MILD STEEL ELECTRODE FOR WELDING CAST IRON

▲ "Harcast," an all-position mild steel electrode for welding and repairing cast iron is the latest development of the Harnischfeger Corporation, builders of P&H welding equipment. Entirely new, completely different in its operating characteristics, P&H "Harcast" represents years of research and experimentation. It fuses well with either mild or medium carbon steel, thus making it ideally suited for joining cast iron with other types of steel. With a yield point of 50,000 pounds psi, the deposited metal has an ultimate tensile strength of 60,000 pounds, roughly double that of a good grade of cast iron.

Usable with either a-c or d-c machines (straight or reverse polarity on d-c), "Harcast" works well at low amperage, thus minimizing the dilution effect at the fusion zone and permitting a higher quality of machining. Reverse polarity on d-c current produces a smooth bead with deep penetration. On d-c straight polarity, penetration is less, higher beads are built, and there is less spread in the fusion zone. In either case — as with a-c current — "Harcast" assures a sound, deep weld for any good grade of cast iron.

MEDART MULTICYCLE

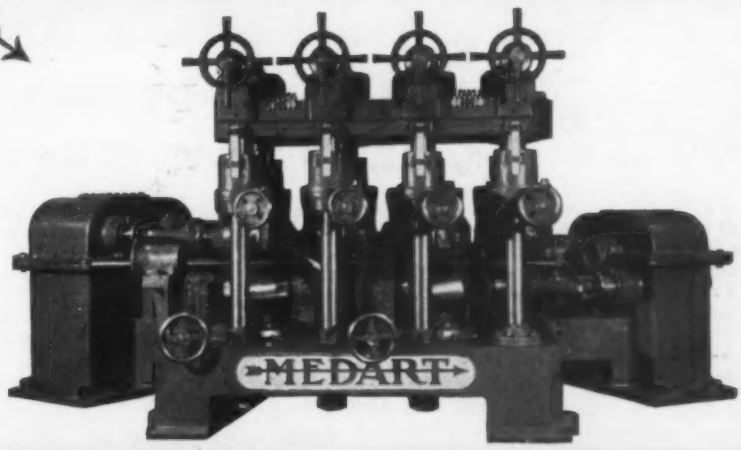
PIPE AND TUBE STRAIGHTENING MACHINE

"6 in 1"

SIX POINTS OF SUPERIORITY IN ONE

1. MULTICYCLE STRAIGHTENING—Two bending rolls impose duplex straightening cycles on workpiece insuring end to end straightness.
2. POSITIVE AND SYNCHRONIZED FEED—All four feed rolls are driven insuring positive synchronized feed and torque balanced around neutral axis of workpiece.
3. THE WORKPIECE LEVEL—Maintains one feeding level for all sizes of pipes or tubes—eliminates need of adjustable entry and delivery tables.
4. NO GUIDES—Horizontal position of the six rolls with balanced torque eliminates requirement for guides.
5. SINGLE MOTOR—All four driven rolls powered from a single motor, for synchronization and economy.
6. NO BEVEL GEARS—All gears enclosed in cases and running in oil, for sure trouble free operation.

"Patents make Jobs"



MEDART

SAFETY AND SERVICE WITH IMPROVED MARKING TOOLS

▲ An improved line of steel marking tools, with safety an integral part of design and construction, are manufactured by the M. E. Cunningham Company, Pittsburgh, Pennsylvania. Known as safety wedge grip stamps, this line features the latest improvements in modern safety engineering.

Made of special steel in standard or special type marking, Cunningham stamps provide clear, speedy identification. They assure deep, clear impressions with maximum service and are perfectly balanced for easy use and efficiency. Safety wedge grip stamps are constructed with knurled sides to assure positive grip and less exertion on the part of the operator.

According to the manufacturer, these marking tools set the standard for safety, dependability and longer service. They will neither spall nor mushroom and give clear, sharp impressions with 50 to 100 per cent more service.

Included in the Cunningham line of marking tools are the safety steel hand stamp, wedge grip radius holder, safety adjustable hand tool, safety axe type holder, safety box type holder and safety heavy bevel and wedge grip letters and figures. There are over 500 available designs of safety date and inspection symbols.

COLD SETTING PLASTIC FOR ELECTRICAL FILLING

▲ The Irvington Varnish and Insulator Company, Irvington, New Jersey, has introduced a unique cold setting plastic to be used as a filling material for junction boxes, stuffing boxes, pot-heads and similar void spaces encountered in electrical work. Known as Cardolite 5616, this liquid resin is mixed with Irvington 5612 setting agent prior to use. Approximately four hours after mixing, the two ingredients will jell at room temperature to the point where flow is no longer possible, and after several days, the end product is a tough rubbery mass which will not flow under heat nor become brittle in the cold. The set compound is insoluble in water, oil, acids and alkalies. Although Cardolite 5616 will adhere to metal, it can be stripped away cleanly to allow repairs to terminals and cable strips.

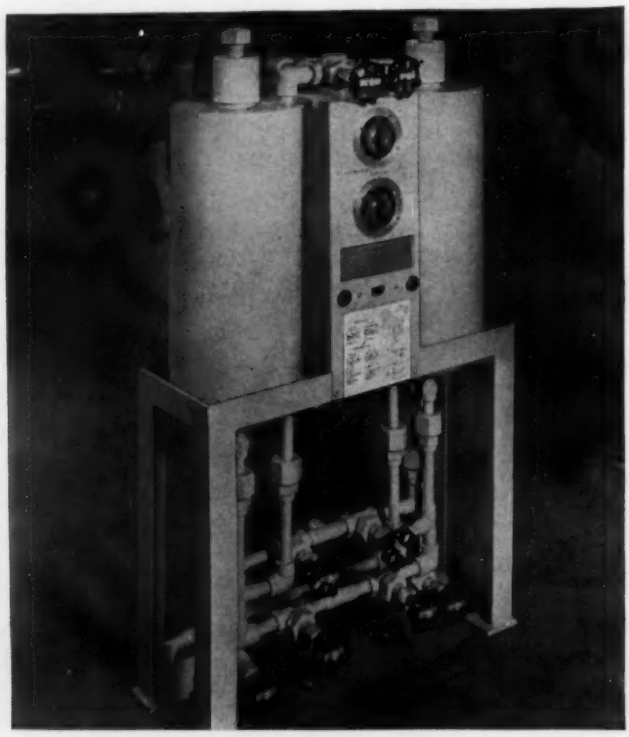
Originally made for filling junction boxes on marine cable installations, Cardolite 5616 is now of interest in all applications where a free flowing material is required which will set to form a rubbery solid.

ARMY-NAVY AWARD TO NATIONAL ROLL

▲ The Army-Navy "E" was awarded to employees of The National Roll and Foundry Company, Avonmore, Pennsylvania. Presentation ceremonies were held at a ceremony on July 3.

This recognition was accorded National employees in a letter from the Honorable Robert P. Patterson, Under Secretary of War. Mr. Patterson pointed out the splendid production record of The National Roll and Foundry Company and the outstanding contribution made by National employees to speed the day of complete victory.

National products — iron and steel cast rolls, heavy iron and steel cast-



Economical! **DEW POINT DEPRESSION** *by* **KEMP** *Dynamic* **DRYERS**

Kemp DYNAMIC Dryers depress dew points at surprisingly low cost—compressed air or gases may be DRIED to very low absolute humidities (sub-zero dew points) for as little as ¼ of a cent per thousand cubic feet (Mcf) DRIED.

Compressed air for your plant probably costs you 6c to 10c per Mcf. Why not spend a fraction of a cent more and get full value from it? DRIED compressed air eliminates corrosion and rusting . . . prevents clogged orifices . . . does away with frozen air lines . . . avoids wastage from "blowing out water" . . . permits accurate instrumentation and continuity of processing . . . saves man power by reducing maintenance costs and trouble-shooting . . .

Reduce operating costs and increase over-all plant efficiency with **efficient** Kemp DYNAMIC Dryers.

ASK FOR BULLETIN—J25D-D

OTHER KEMP PRODUCTS

Nitrogen Generators ▪ Inert Gas Producers
Atmos-Gas Producers ▪ Immersion Heaters
Flame Arrestors for vapor lines, flares, etc.
The Industrial Carburetor for premixing gases
Submerged Combustion Burners
A complete line of Industrial Burners, and Fire Checks.

Address The C. M. Kemp Mfg. Co. 405 E. Oliver St., Baltimore 2, Maryland

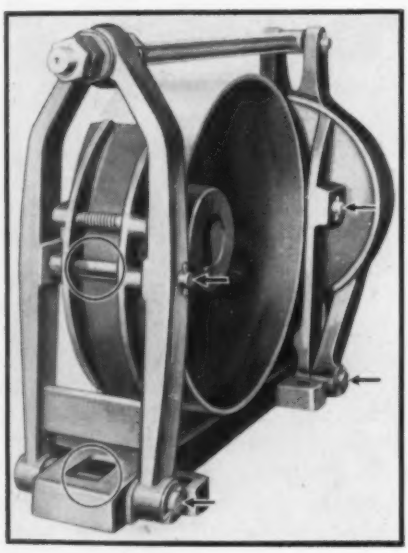
KEMP of BALTIMORE

ings, rolling mill equipment — internationally recognized during peacetime, have been expanded and developed for special applications to our armed might throughout the world. Of particular importance has been the production of a heavy tonnage of tank armor and 8 in. howitzer gun castings.

A total of 489 employees are eligible to receive the coveted lapel pins that signify distinguished service to their country. In addition, there are 148 employees now on leave-of-absence to serve with the armed forces.

TUBES PROTECT PINS IN IMPROVED BRAKE DESIGN

▲ To facilitate removal of the pivot pins in cases where magnetic brakes are given frequent and heavy coats of protective paint or where mill dirt, moisture and weather conditions tend to corrode equipment, the pins on Cutler-Hammer type "M" shoe brakes are now protected by enclosing tubes.



Protecting tubes over pins indicated by arrows permit speedy, easy removal for relining.

The length of the tube completely enclosing the exposed section of the pin is fastened directly to the bearing without touching the pin. This leaves the pin free for speedy and easy removal when it becomes necessary to renew the brake lining.

Illustrated literature on the d-c Type "M" magnetic shoe brake can be obtained by writing to Cutler-Hammer, Inc., 315 North 12th Street, Milwaukee, Wisconsin.

COMPRESSOR IMPROVEMENTS REDUCE CYLINDER WEAR

▲ Cylinder wear of approximately one-thousandth of an inch per 10,000 horsepower hours, about one-tenth the normal wear rate, has been reported on various GMV compressor installations by The Cooper-Bessemer Corporation, Mount Vernon, Ohio, and Grove City, Pennsylvania.

Signifying the steady progress in the design and construction of the V-type compressor units, inspection reports from the company's files reveal one case where cylinder wear for the compressor installation at the Continental Oil Company, Benevides, Texas, had .003-inch cylinder wear after 23,000 hours of operation, or about .001-inch per 9,500 operating hours. This is almost ten times better than the normal wear rate.

An installation at the Federal Glass Company of Columbus, Ohio, showed only .001-inch of wear on the power cylinders after three years of operation.

Some of the principal develop-

FOR BETTER STEEL
and more of it...
use this
SIMPLE AUTOMATIC CONTROL
These Hays instruments may be used individually or in combination . . .
TYPE CDE-X FURNACE PRESSURE CONTROLLER with external manual adjustment for automatically operating stack damper to hold pressure constant.
SERIES FOT PRESSURE INDICATOR an easy-to-read measurement of furnace pressure; usually connected at furnace roof.
SERIES OT PRESSURE RECORDER a daily 24-hour record of furnace pressure shows timing of eversals and each change of pressure made by operator during the heat.
A VITAL FACTOR in producing better steel—and more of it—is the automatic regulation of open hearth furnace conditions by means of Hays Pressure and Temperature Control. Operators are relieved of many time-consuming details, have more time for the more important business of making steel.
Hays Automatic Pressure Controller is simple to install, easy to understand and to operate. When desired, control can be done manually from a central panel through remote operation.
It's important to know about Hays partial or complete instrumentation. A Hays engineer can tell you all about it—representatives in all principal cities of United States and Canada. Phone or write.
The HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROLS
1945 SHIRL AVENUE
MICHIGAN CITY, INDIANA, U.S.A.

ments which have contributed to this phenomenally low cylinder wear, according to engineering authorities of the manufacturer include the extensive use of Meehanite metal, an exceptionally close-grained iron alloy which gives extra strength and wear-resistance; extensive research which has brought about a considerable reduction in piston ring thickness, the narrower rings providing ample seal and causing less wear; and a piston design which permits effective, uniform heat dissipation.

There have also been numerous refinements in the fabrication and finishing of the cylinder components, including the use of the world's largest vertical honing machine which is designed to attain utmost precision in cylinder finishing.

WELD SPATTER REDUCED BY LIQUID COATING

▲ A liquid designed to minimize the adherence of welding spatter to metal and reduce cleaning time has been introduced by The Lincoln Electric Company, Cleveland, Ohio.

This new product which is priced at only a few cents a quart is known as Lincoln "Non-Spatter" film. The liquid has been thoroughly tested in the field and found to possess the following characteristics:

Welded truck wheel showing absence of spatter on areas treated with Lincoln "Non-Spatter" film.

Welding can proceed after application, whether the film is still wet or dry.

Film can be sprayed or painted on work

Priming coats of paint may be readily applied over the film.

If it is desired to remove the film before painting, this can be readily accomplished by washing with water.

One application of film is effective for multiple-pass welding.

If film is sprayed or painted on parts prior to being normalized, the oxide film and ordinary scale can be removed more easily after heat treating.

Lincoln "Non-Spatter" film is supplied in concentrated form in 5 gallon cans for the convenience of the user. By diluting the concentrated material with three parts of water, 20 gallons of film fluid is obtained.

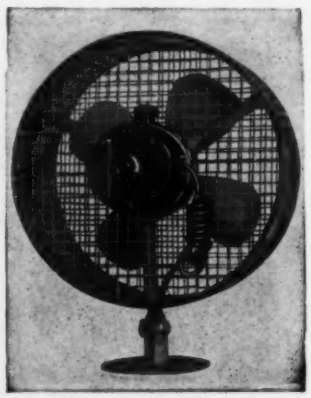
Either brush or air gun can be used to apply the film to the areas adjacent to the joint to be welded and to welding jigs that may be subjected to spatter. After welding, the spatter can be easily removed by wiping or brushing, thus reducing cleaning time to a minimum.

ELECTRIC MARKER FOR ALL KINDS OF MATERIAL

▲ Anything and everything can be marked with a New Electric Marker just announced by the Ideal Commutator Dresser Company, 1045 Park Avenue, Sycamore, Illinois.

Although small in size, only 6 in. long and 10 ounces in weight, life tests prove that this new Marker can be

IS HEAT SLOWING UP YOUR WORKMEN?



TRUFLO CRANE CAB FANS
For cooling interiors of crane cabs and other confined areas. Adjustable both horizontally and vertically. Four blade type, 12 and 18 in. sizes.

Keep Them COOL with TRUFLO FANS

TRUFLO PORTABLE COOLING FANS
Easily portable. Help keep efficiency high where work is hottest. 12 to 36 inch diameters.

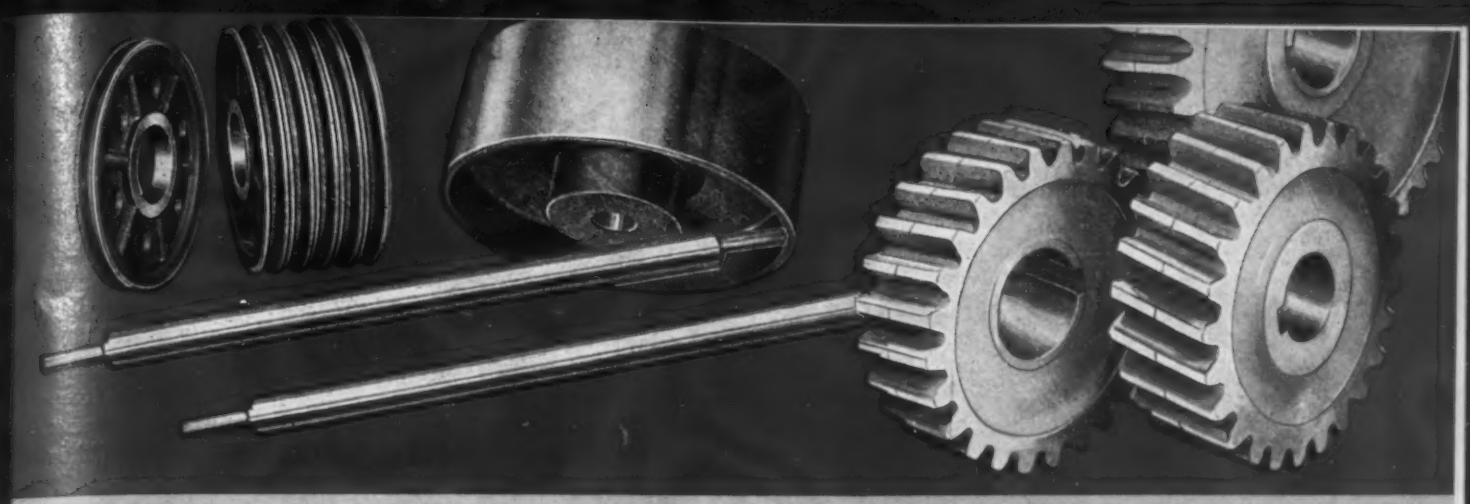
Production suffers when workmen are overheated. Steps begin to drag, efficiency falls.

Now, when speedy production is vital, Truflo Fans can help keep your workmen on their toes. All Truflo Fans are designed and built correctly to put fresh cool air *in large volumes* exactly where it is needed. Perfectly-balanced shafts and blades give more air per h.p. . . . strong steel frames stand up longer under hard use . . . rugged wire guards protect men against injuries.

All of the following types can help beat the heat, keep production moving in your plant. Write for illustrated literature.

PORTABLE COOLING FANS
CRANE CAB FANS • WALL FANS
EXHAUST FANS • BLOWERS
ROOF VENTILATING FANS
PENT HOUSE FANS

TRUFLO FAN COMPANY
554 MAIN ST., HARMONY, PA.



"TOOL STEEL PROCESS"

SPECIALLY HARDENED STEEL PRODUCTS

"TOOL STEEL PROCESS"

GEARS • PINIONS • SCREWDOWN SCREWS AND NUTS
BRAKE, CRANE AND SHEAVE WHEELS • ROLLS
SPROCKETS • MILL HERRINGBONE PINIONS

are guaranteed **to reduce your maintenance costs through longer life and more production.**

THE TOOL STEEL GEAR & PINION COMPANY

CINCINNATI, OHIO

used continuously on the toughest of marking jobs.

Using an entirely new principle in design, the power of the cutting stroke has been increased by 30 per cent over previous models. Yet, an adjusting nut makes it possible to vary the impact so that it can even be used to mark on glass. Shaped to fit the hand, it can be held and used to write almost as easily as a pencil.

The Ideal marker operates from any a-c electrical outlet. Operating like a small electric hammer, it makes 7200 cutting strokes per minute, cutting right into the surface leaving lines that cannot be wiped away or worn off with ordinary usage. It permanently marks sizes, names, numbers and other important information on tools, parts and finished products, and marks iron, steel, bronze, aluminum, ceramics, tile, marble, lead, plastics, porcelain, glass, etc.

All parts are enclosed and ready for use. For average marking, a hardened alloy point is furnished as standard. If extra hard materials from 54 up to 64 Rockwell hardness scale C are to be marked, a diamond point is recommended.

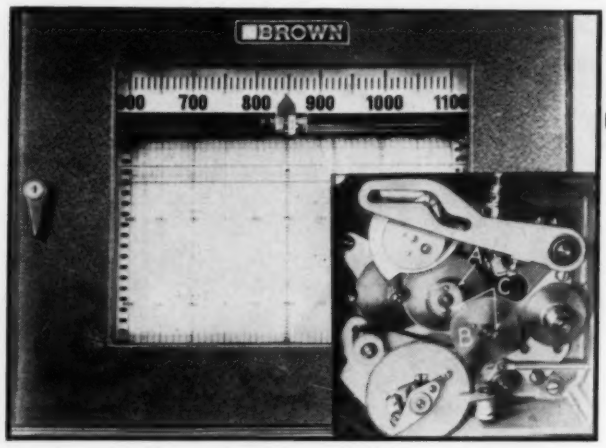
HIGHER CHART SPEEDS ON ELECTRONIC RECORDERS

▲ Increased industrial use of electronic recorders has been made possible, it is announced by Brown Instrument Company, by stepping up chart speeds of Electronik Pyro-Potentiometers.

The standard speed electronic recorder, single or multiple point models, incorporate gear changes for speeds of 5, 10, 15 and 20 inches an hour, it was said at the Philadelphia division of Minneapolis-Honeywell Regulator Company.

Fast speed electronic models, single or multiple point, will have internally mounted gears for speeds of 10, 20, 30 and 40 inches an hour.

As shown in the accompanying illustration, the gears are changed by removing screw "C" from gears "A" and "B" and by lifting the gears from the assembly. The new speed gears are then installed and screw "C" is replaced.



By changing gears A and B, four different chart speeds may be obtained on this recording pyrometer.

Shire Moot:
A meeting of the court when knighthood was in flower, presided over by sheriff and landowners. The usual sentence was bodily roasting or dunking, to the amusement of all but the accused.
★ ★
We too have a "No Parking" sign in our product development department. We also "keep moving" with improvement on long established items. If we have to take a little "roasting" now and then, it only makes us try a little harder to perfect our product.
Use MORGANITE and know you're right!
NO PARKING
Morganite
CARBON BRUSHES
MORGANITE BRUSH COMPANY, INC., LONG ISLAND CITY 1, N.Y.

ELECTRIC METAL MAKERS GUILD ELECTS OFFICERS

▲ At a recent meeting of the Electric Metal Makers Guild, Inc., the following officers were elected for the coming year: president, J. A. deBondy, superintendent of melting, Manitoba Steel Foundries, Ltd., Selkirk, Manitoba, Canada; vice-president, J. E. Arthur, superintendent of melting, Crucible Steel Company of America, Park Works, Pittsburgh, Pennsylvania; secretary-treasurer, D. L. Clark, superintendent of melting, Simonds Saw and Steel Company, Lockport, New York.

DIRECTORS DEVELOP STEEL MERGER PLANS

▲ The board of directors of Wickwire Spencer Steel Company, at a recent meeting, accepted in principle the proposal of the directors of Colorado Fuel and Iron Corporation for the merger of the two companies, and appointed a committee of the board, consisting of Messrs. E. C. Bowers and R. T. Dunlap, to negotiate a formal merger agreement with the directors of Colorado Fuel and Iron Corporation.

When a merger agreement has been approved by the directors of both corporations, it will, in accordance with applicable laws, be submitted to the stockholders of the respective corporations for their action.

ACCIDENTS INCREASE IN LAKE ORE DISTRICT

▲ An increase in the frequency and severity of accidents in iron ore mines of the Lake Superior district during the four years 1940 to 1944 is reported in a comprehensive survey of accidents records for the region released recently by Dr. R. R. Sayers, Director of the Bureau of Mines.

Employing about 25,000 men, the Lake Superior district produces 85 percent of the Nation's domestic iron ore tonnage. There are about 120 iron ore mines operated by 26 companies.

Heavy wartime production schedules and a shortage of skilled manpower were among the causes contributing to the rising accident trend in the years 1940-43 inclusive, according to the Bureau's report. In 1940 the frequency rate was slightly over 12 accidents for each million manhours of work, while by 1943 it had risen to 21 lost-time injuries per million manhours.

The severity curve for the same four-year period was upward during 1940, 1941 and 1942, with a slight decrease for 1943.

Although the Lake Superior district accident rates increased, they still were lower than the rates in other metal mining districts and generally under the rates of metal mines entered in the National Safety Competition, the Bureau's survey reveals.

A breakdown of the figures for the four-year period shows that in the district there were 110 fatal accidents, 57 partial permanent injuries, and 2,654 temporary disabilities, or a total of 2,821 accidents of all kinds.

A copy of Information Circular 7321, "Accident Experience, Iron Ore Mines — Lake Superior District, 1940-43," by Frank E. Cash and Reuben D. Larsen, may be obtained from the Bureau of Mines, Department of the Interior, Washington 25, District of Columbia.

Type WMK Enclosed Safety Switch

CONDULETS

are **rain-tight.** You can use them in **both** indoor and outdoor non-hazardous locations. Also suitable for Classes III and IV hazardous locations. (NEMA Types 3 and 5)

Feraloy cases. Strong and durable. Four sturdy mounting feet. Many possible conduit arrangements for both horizontal and vertical through feed.

Safety. Positive interlock prevents opening the case unless switch is "off." Dead front switch held in "off" position while case is open.

Padlocks.

1. Cover may be padlocked to prevent unauthorized entry.
2. Operating handle may be padlocked "on" or "off."

Threaded operating shaft. Bearings permanently lubricated. Resists corrosion. Prevents the entrance of dust and moisture.

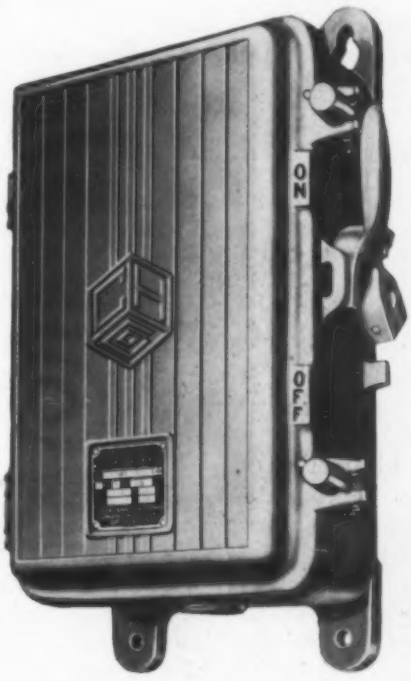
Switches. Quick make and break mechanism. Double break, reinforced, positive pressure-type blade and jaw construction. Positive pressure fuse clips. Combination solder or solderless wire lugs.

30, 60, 100 or 200-Ampere.
1 to 50-H.P

125 to 600-volt, A. C.

2 or 3-pole, fusible or fuseless.

Listed in Condulet Catalog No. 2500, Section 50, Page 20A.



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New Literature

▲ Reliance Electric and Engineering Company, Cleveland, Ohio, announces the publication of an instruction sheet (No. 3042) covering the grease lubrication of anti-friction bearings in Reliance a-c and d-c motors, V-S drives and motor generator sets.

Available on request, the four-page bulletin details construction, maintenance and lubrication recommendations for double-shielded ball, open ball, and spherical roller bearing types as installed on Reliance equipment.

▲ A 72-page catalogue of the publications and patents which have resulted from fifteen years of fundamental and applied Battelle research has just been published by Battelle Memorial Institute, Columbus, Ohio.

Founded to advance education, science, and industry through research and through the dissemination of technological information, Battelle has published widely in the nation's technical and scientific journals. The new catalogue lists more than eight-hundred such journal contributions, books, and patents between the years 1929-1944, inclusive.

The catalogue includes subjects in the fields of organic chemistry, electrochemistry, chemical engineering, graphic arts, welding technology, applied mechanics, mineral dressing, industrial physics, ceramics, fuels, and metallurgy.

▲ The new 1945 Lubriplate Service Handbook, prepared by Fiske Brothers Refining Company, 129 Lockwood Street, Newark 5, New Jersey, contains much valuable information on the subject of lubrication and will prove of considerable interest to engineers and operators concerned with lubrication.

The booklet gives characteristics of Lubriplate products, discusses their application, and makes recommendations for various types of equipment. A copy will be mailed to those interested.

▲ The dry cyaniding process as carried out in continuous furnaces developed for the purpose is described in a new four-page bulletin No. SC-124, just issued by Surface Combustion Corporation, Toledo, Ohio. Employing a gaseous atmosphere which contains carburizing gases and ammonia, the process combines features of both carburizing and cyaniding in obtaining a flexible and continuous control of carbon and nitrogen in the case structure.

Details covering the action of the process, photomicrographs comparing the results of bath and dry cyaniding, suitable temperatures, applicable types of steels, the atmosphere constituents and examples of numerous parts to which the process has been applied, are presented in addition to illustrations of the furnaces. Data on case depths, hardness ranges and cooling cycles are also included.

▲ A new 68-page brochure lists unusual performance qualities of Gatke moulded fabric bearings and describes advantages in meeting difficult and unusual service conditions. The publication also lists performance reports showing results under widely varying service conditions and illustrates numerous types and sizes in which Gatke bearings are being moulded to required dimensions for installation without machining. Copies may be had upon request to Gatke Corporation, 228 N. LaSalle Street, Chicago 1, Illinois.

▲ A new catalog published by Edgar E. Brosius Company, Pittsburgh, Pennsylvania, covers their special equipment for blast furnaces and steel mills. Discussed and illustrated in the booklet are Brosius auto floor chargers and manipulators, overhead chargers, goggle valves, clay guns, grab buckets, slag granulating mill, and soaking pit cover carriage. Copies of the catalog are available upon request.

▲Recently published by Mir-O-Col Alloy Company, 2416 E. 53rd St., Los Angeles, California, the "Weldors Guide to Hard Facing" sets forth the results of 20 years of research and successful application of hard facing. Covering both acetylene and electric methods, the booklet gives detailed instructions for hard-facing various types of equipment. Copies are available upon request.

▲ Air Reduction is now distributing a new electrode catalog which is said to be one of the most complete and elaborate books of its kind ever issued. Beginning with a full color page showing color markings of various electrodes catalogued, the 56-page book contains a combined electrode selector chart and index, illustrated sections on mechanical properties and testing and on approvals.

The entire line of Airco electrodes for welding mild steel, alloy steels, stainless steels, galvanized sheet steel, aluminum and other nonferrous metals and for hardfacing is covered, with complete descriptions and details of applications, welding procedure, mechanical properties, chemical analyses and specifications. Copies may be obtained from Air Reduction, 60 East 42nd Street, New York 17, New York, or from any Airco office.

▲ An envelope size folder has just come from the press describing and showing in natural color precision machined bars made from a specially tough and strong bearing alloy, Shook 664 phosphor bronze.

The folder lists over 400 stock sizes of Shook bored bronze bars to enable users to avoid material waste and conserve machining time.

The folder offers babbitt metals, too, in three special types, for general purpose, for heavy pressures and for extra pressures, with high speed and shock loads.

For copies of this new folder, address Shook Bronze Corporation, Lima, Ohio.

▲ The Bird-White Company, 3119 West Lake Street, Chicago 12, has just published bulletin No. 12 describing the new temperature exchanger now available for delivery. In addition, patented features and the advantages of these units as after-coolers, purifying and external heating units is fully described. Engineering drawings showing multiple unit installations for air or gas lines are also presented. Complete specifications of the models available as well as the minimum and maximum cfm capacities of each model will be found in this new bulletin.

▲ Just published by American Foundry Equipment Company, 555 S. Byrkit Street, Mishawaka, Indiana, are five individual catalogs on their complete line of airless Wheelabrator tables, both multi-rotary table and plain table types.

A catalog on the size machine suited to individual requirements will be mailed upon request.

▲ "The A B C of Power Factor," a new 20-page fact-filled booklet that

FOR YOUR TOUGHEST MATERIALS HANDLING JOBS . . . SPECIFY THE NEW
PHILCO "THIRTY"
-with 30% Longer Life!
The tougher the jobs, the better this new Philco "Thirty" Storage Battery shows up. For long ramps and heavy loads — Philco "Thirty" delivers the power. And — in addition — it gives 30% longer life! Write today for the new Philco "Thirty" catalog.
The new Philco "Thirty" for electric industrial trucks is identified by its distinctive red connectors.
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STORAGE BATTERY DIVISION
TRENTON 7, NEW JERSEY

explains power factor in detail, has been published by Electric Machinery Manufacturing Company, East Minneapolis, Minnesota. Well illustrated, fully authentic and printed in three colors, the booklet discusses power factor, why low power factor is detrimental, how to get high power factor, and how to make power factor calculations.

▲ Printed copies of Simplified Practice Recommendation R210-45, Carbon-Brush Terminals (Electric), and Miscellaneous Publication No. 180, Guide-chart for Carbon-Brush Terminals (Electric), are now available, according to an announcement of the Division of Simplified Practice, National Bureau of Standards.

This illustrated recommendation, which becomes effective on July 15, 1945 provides a practicable simplified list of stock sizes, types, and varieties of carbon-brush terminals to satisfy normal requirements for all sizes and types of rotating electric apparatus, and is intended to assist the industry in expanding production to meet the needs of the war agencies and of regular industrial users, and to pave the way for future uniformity.

Miscellaneous Publication No. 180 is a replica of the chart in the recommendation, on paperboard and enlarged to 16 by 19 inches, suitable for display in shops and workrooms.

Copies of the Simplified Practice Recommendation and the separate Miscellaneous Publication may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., for five cents each. A discount of 25 per cent on orders of 100 or more copies, of either or a combination of both, is available to those desiring to purchase a supply of these publications for business purposes.

▲The B. F. Goodrich Company, Akron, Ohio, has just published a new catalog section on portable electric vulcanizers, which is now available upon request.

Describing the special construction features of each of the portable belt vulcanizers which is in its line, the catalog section gives service conditions under which each type operates in detail and contains a table giving complete dimensions on each vulcanizer, number and dimensions of platens, widest belt which can be spliced in it, and wattage consumed.

▲ The George Scherr Company has just published a new 8-page folder entitled "Speed Surface Grinding Set-ups." The folder is profusely illustrated with actual applications of Magne-Blox products employed to hold various types of work for surface grinding operations which may aid in solving holding problems that are constantly coming up in the grinding department.

Featured also is a new service offered by the George Scherr Company, namely, the production of special sizes of Magne-Blox parallels, V-blocks and angle irons, as well as other shapes and forms to fit any type of magnetic chuck. This 8-page folder on grinding is available without charge by writing to the George Scherr Company, 200 Lafayette Street, New York 12, New York.

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Cutaway of L-R Type "H" illustrates rugged, simple construction:

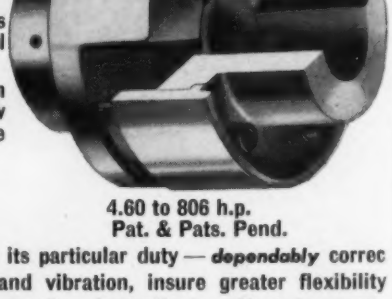
Electric steel castings — greater number of jaws — greater load-carrying capacity.

Individual free-floating load cushions between jaws — held by inside steel sleeve and removable steel collar.

Half of cushions idlers (except on reversing loads). Hence always a new set of cushions. Quick interchange without shut-downs.

No lubrication required.

Heavy Duty



4.60 to 806 h.p.
Pat. & Pats. Pend.

Cushion materials — each suited to its particular duty — *dependably* correc misalignment — absorb shock and vibration, insure greater flexibility and quietness. Cushions are free instantly to adjust to emergencies. Brake-lining, leather, rubber-duck, and armored rubber are among materials used. Cushions are always in sight for inspection.

Every Engineer should have L-R Selector Charts.

Charts free with L-R Catalog which shows couplings for every service 1/6 to 2500 h.p. Lead right to couplings desired, without tedious figuring. Weights, prices, etc., right at hand. Special couplings also engineered. Wire or write.

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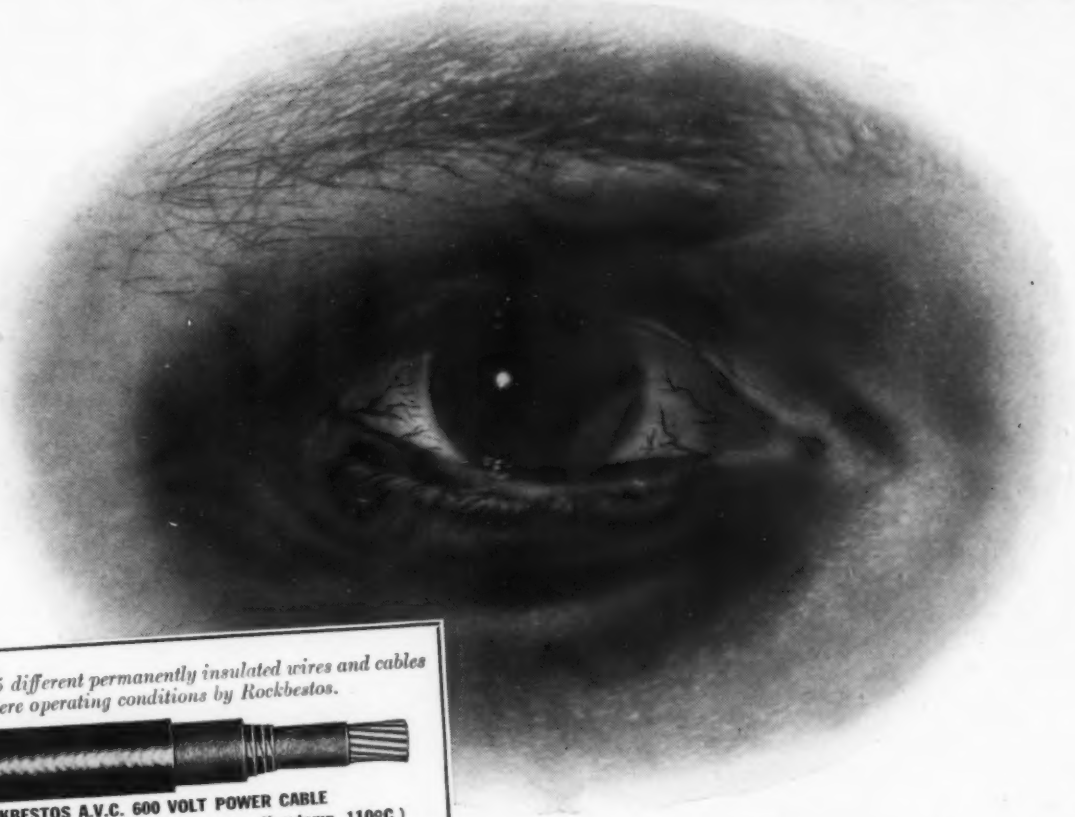
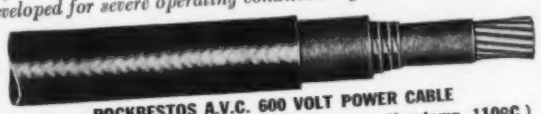
ARE WIRE-FAILURES

GIVING YOU A BLACK EYE?



A few of the 125 different permanently insulated wires and cables developed for severe operating conditions by Rockbestos.



ROCKBESTOS A.V.C. 600 VOLT POWER CABLE

(National Electrical Code, Type AVA—max. operating temp. 110°C.)

Sizes No. 18 AWG to 2,000,000 CM insulated with felted asbestos and varnished cambric, and covered with an asbestos braid. Other constructions for service voltages up to 5000.

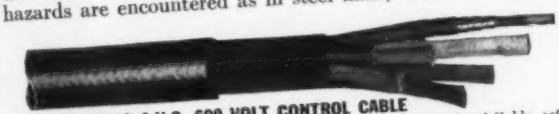
This cable is recommended for power circuits and hot-spot wiring in or around boiler rooms, ash pits, steam tunnels, soaking pits, tenter frames, glass plants, steel mills, etc. The asbestos and heat-sealed varnished cambric construction has ample moisture resistance and withstands high temperatures indefinitely.

ROCKBESTOS A.V.C. 600 VOLT MOTOR LEAD CABLE

(National Electrical Code, Type AVA—max. operating temp. 110°C.)

Sizes No. 18 AWG to 1,000,000 CM insulated with two walls of felted asbestos and a high-dielectric varnished cambric insert, with a heavy asbestos braid overall.

Heatproof, fireproof, greaseproof and oilproof, this cable will not dry out and crack, won't burn or carry flame, and will remain permanently flexible. For coil connections, motor and transformer leads where overloads, extreme heat and fire hazards are encountered as in steel mills, boiler rooms, etc.



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In one to 19 conductors with individuals insulated like Motor Lead Cable, cotton braid covered, and cabled with an asbestos braid over all. Standard strandings AWG No. 12—19/ #25 and No. 9—19/#22. Other strandings on order.

Designed for use under conditions too severe for control cables with other types of insulation which deteriorate rapidly when exposed to high temperatures. Operates without failure under the attack of heat, oil, grease or corrosive fumes and may be installed in conduit as it has ample moisture resistance.

Is your producing machinery missing in action too often because power leads are failing under insulation-baking overloads? Are heat-weakened control circuits causing too much time-out? Do oil-soaked motor leads give up just when everything should be humming?

Then you're due to go in for some wire-failure elimination with Rockbestos A.V.C. *permanently insulated* wires and cables . . . built to take the heat up to 230°F. without drying out, cracking or flowing under the baking . . . and without rotting or blooming when exposed to oil, grease, alkalies or corrosive fumes.

For failure-free circuits install Rockbestos A.V.C. alongside blistering steam lines and kilns, in thermometer-boosting boiler rooms and tunnels, and around forging presses, soaking pits and steel mill furnaces . . . in fact, anywhere that other wires are kicking out too often.

Send for our catalog showing a complete line of *permanently insulated* Rockbestos wires, cables and cords, including many of the 125 standard constructions and National Electrical Code types we designed for failure-prevention. Write to the nearest district office or:

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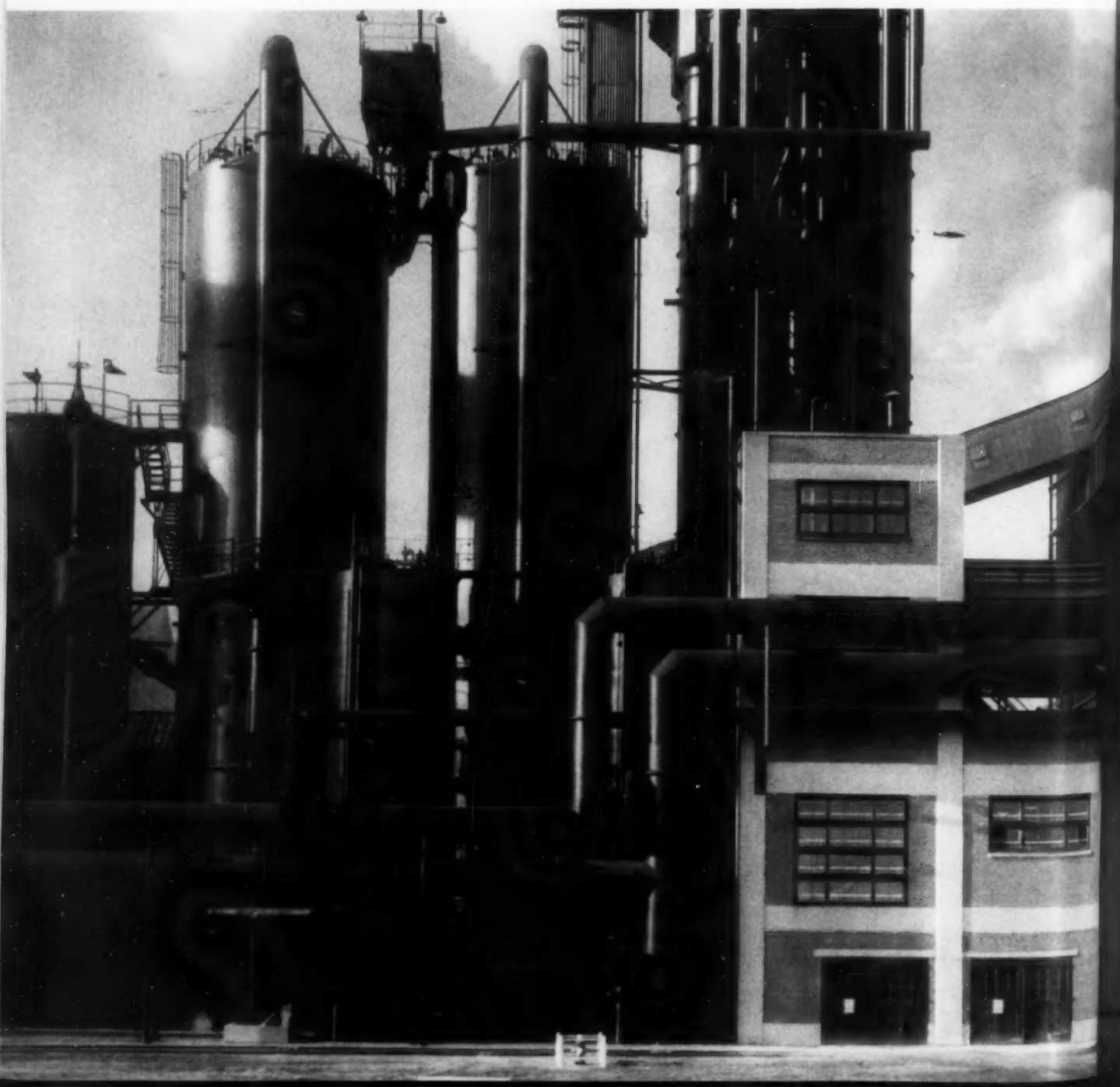
GAS PURIFICATION

will remove 98%

of the hydrogen sulfide from

54,000,000 cu. ft. of Coke-oven Gas per day,

producing 6 tons of brimstone sulfur which is solidified on a



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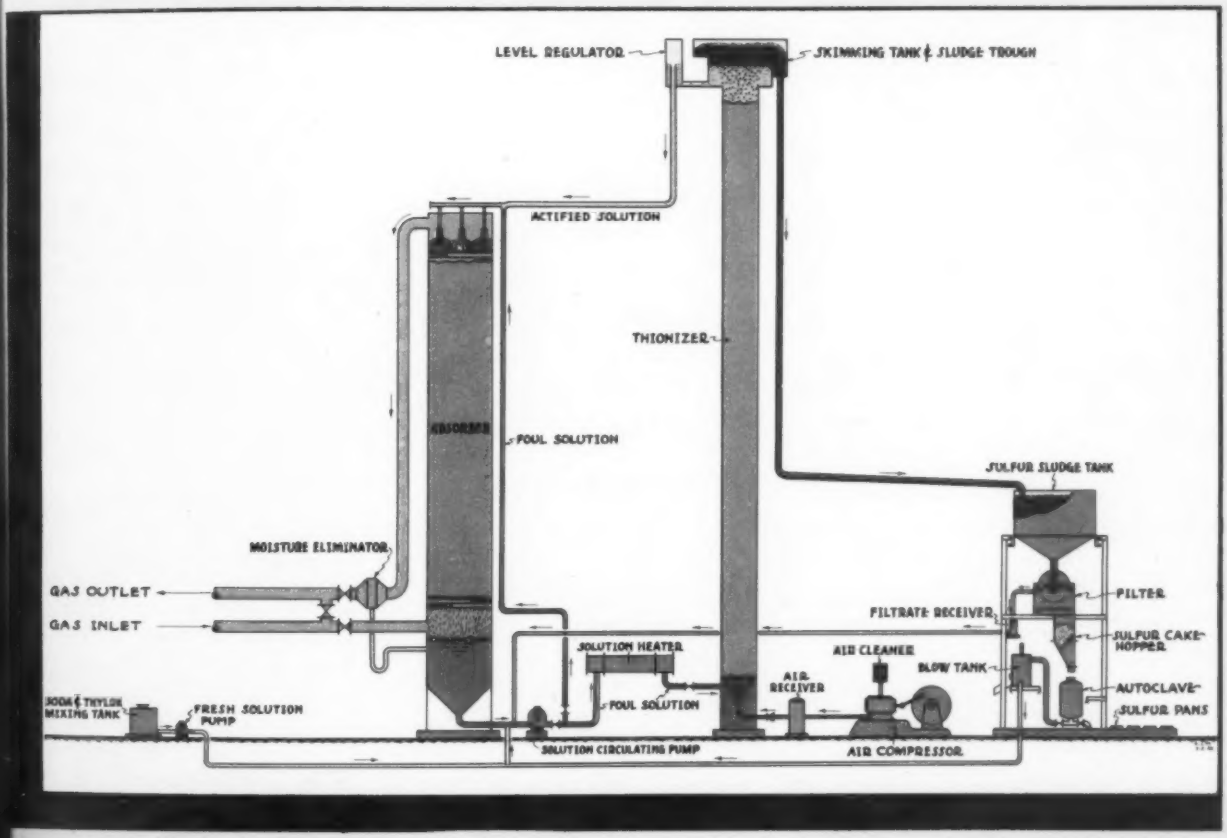
stainless-steel belt, stored in a silo and loaded into railroad cars by a conveyor. The Purified Gas contains less than 5 grains of hydrogen sulfide per 100 cu. ft. *This is one of the largest installations of its kind in the world.*



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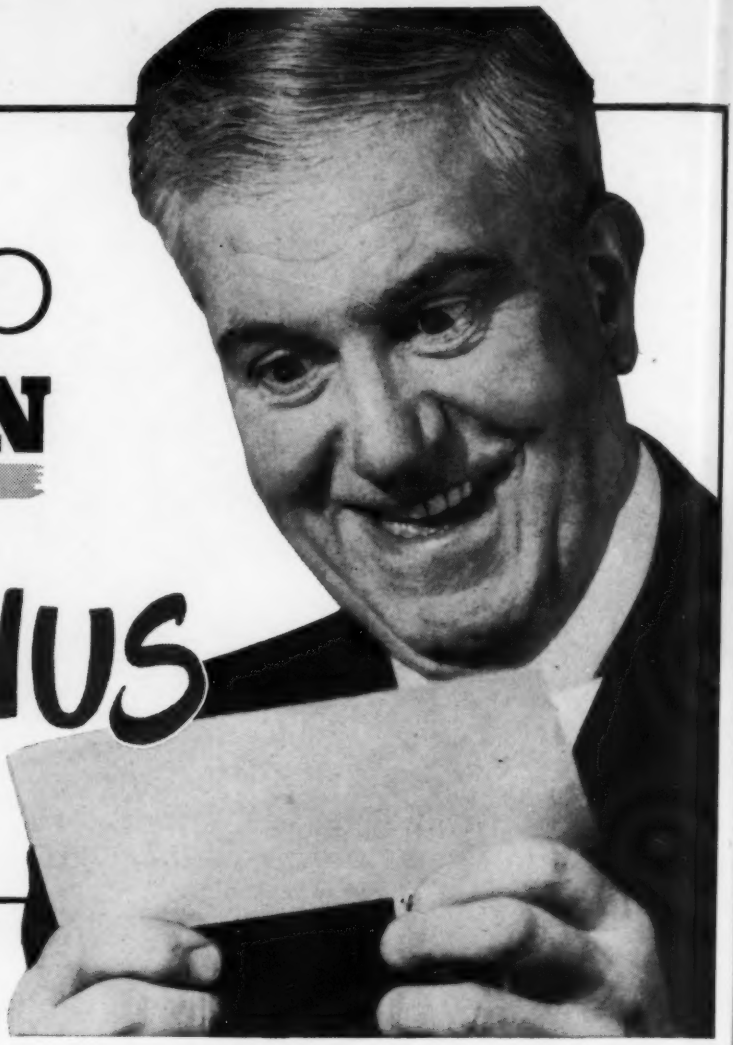
In the purification of coke-oven gas Koppers development leads!

How to EARN a BONUS



Bonuses are earned by men with imagination, foresight and ability—for with these qualities they take steps to prevent some of the difficulties which would otherwise interfere with production.

For example—operators who installed Bloom Combination Burners kept their furnaces in service on oil when gas shortages caused shutdowns elsewhere. Where Bloom equipment is installed, there need be no delays due to gas shortages.

Broad experience in the application of both oil and gas fuels enables Bloom Engineering service to guide you in the application of these burners for greatest efficiency and effectiveness.

Write for Bulletin 1001, containing full details; principle of operation, capacities, dimensions, weights, etc.

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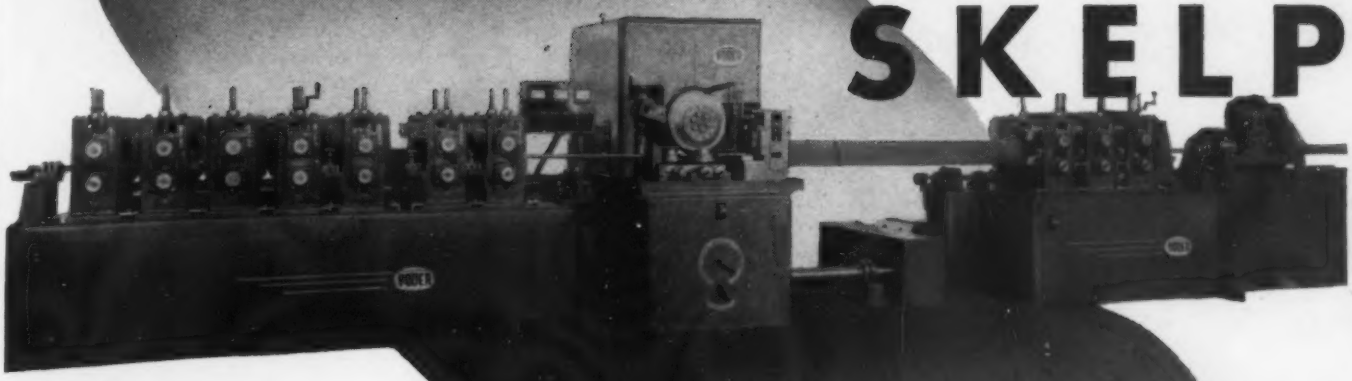

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Because . .

Profitable yield is measured in TONNAGE PER YEAR rather than feet per hour. Yoder mills are built for continuous production from hot rolled skelp with a minimum of down time and service cost. Result is Yoder mills install for a quarter the cost of so-called high-speed mills, yet PRODUCE MORE SALEABLE TONNAGE and cost less to operate . . . Let a Yoder engineer give you the complete low-down on the engineering that enables Yoder mills to take the brutal effects of handling Hot Rolled Skelp, and like it.

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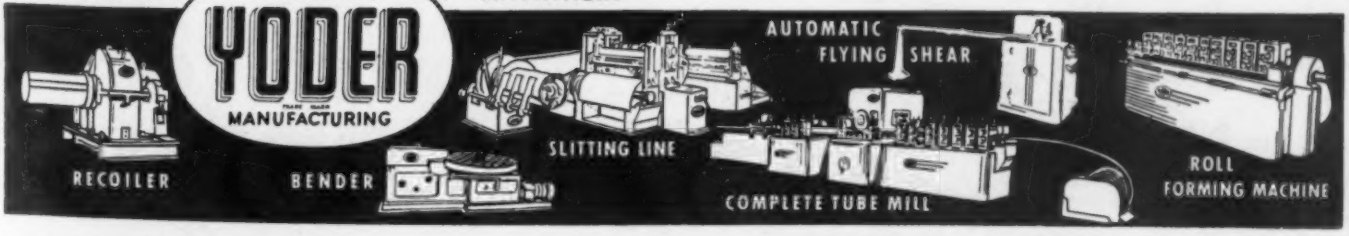

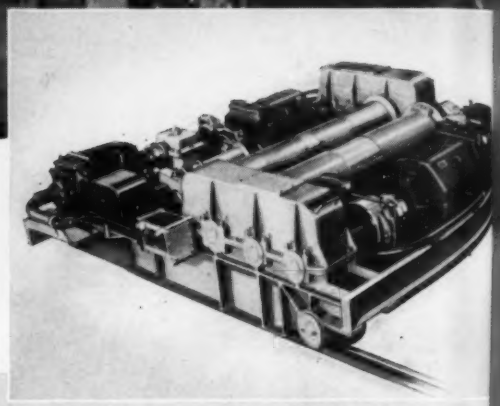

MORGAN 60-TON, 100′0″ SPAN HEAVY-DUTY MILL TYPE CRANE

BUILT BY MORGAN *Engineering*

● Illustrated is one of two Morgan heavy-duty mill type cranes in a strip mill. Morgan superiority of design and construction is built into every part to insure many years of profitable service. They are equipped with fabricated welded trolleys and bridge trucks, hydraulic bridge brakes and anti-friction bearings throughout. Trolleys are of the gear box type using plain motors with flexible couplings. An auxiliary girder is provided for helping to support the cage, bridge motor and control units. Morgan engineers rely upon a highly skilled shop organization, modern equipment and progressive ideas in building heavy-duty mill type cranes.

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Personnel News

J. L. Hyland, manager of the Cleveland district of Republic Steel Corporation, has been given a leave of absence to become a deputy chief of the metallurgical branch of the U. S. Control Council in Germany. In this capacity he will work with **R. J. Wysor,** former Republic president, who is heading the branch which has been appointed in connection with the metallurgical industry control in Germany.

Mr. Hyland's experience in the steel industry dates back to 1906 when he started as a chemist. Nine years later he became chief chemist of the Illinois Steel Company, Gary, and in 1930, when he left to become district manager of Republic's Chicago district, he was superintendent of open hearth steel production with the Gary plant of Carnegie-Illinois Steel Company. In 1939 he was made manager of Republic's Cleveland district.

J. H. Slater, assistant district manager of Republic's Cleveland district, has been named acting district manager.

Mr. Slater is a graduate of Case School of Applied Science and has been associated with steel since 1912. He has worked with the American Steel & Wire Company, National Tube Company — Lorain, and the United Furnace Company at Canton. Before coming to Cleveland he was superintendent of blast furnaces and coke ovens in Republic's Warren operations.

H. L. Allen, open hearth superintendent, has been appointed acting assistant district manager.

W. C. SNYDER, JR.

William Cordes Snyder, Jr., identified with the steel business for 20 years in various executive capacities, has been made president and general manager of Continental Foundry & Machine Company. To take over his new post he resigned as a vice president and director of Blaw-Knox Company and president and general manager of the Lewis Foundry and Machine division of that company. Headquarters of Continental will be in the Grant Building, Pittsburgh. Mr. Snyder succeeds **G. N. Hermann,** who asked to be relieved of the presidency of the company in view of his desire to move to California, where he will continue to be associated with the company as general sales representative for the entire West Coast area.

Frank E. Walling, vice president in charge of operations of the Lewis Foundry & Machine Division of the Blaw-Knox Company, has been named acting manager of the division, assuming the duties formerly held by **W. C. Snyder, Jr.**

Mr. Walling is a native of Middletown, N. Y., where he attended public and high schools. He was graduated from Lehigh University in 1934 with the degree of master of science. For four years thereafter, he was associated with the Lukens Steel Company in Coatesville, Pa.

In 1938, Mr. Walling became superintendent of rolling of the Duquesne Works of the Carnegie-Illinois Steel Corporation. He joined the Lewis Foundry and Machine Division of the Blaw-Knox Company in 1941 as assistant to the manager, and last year was promoted to vice president in charge of operations.

G. S. CRANE

F. R. Bacon, founder of Cutler-Hammer, Inc., has been elected chairman of the board for the company. He has been president from 1896 to the present time excepting for the period between May, 1924 and April, 1931 when **B. L. Worden** was president and Mr. Bacon chairman of the board. He now resumes the position of chairman of the board which he formerly held.

H. F. Vogt now becomes chairman of the company's executive committee and continues as vice president. In addition Mr. Vogt was elected treasurer.

G. S. Crane, formerly vice president in charge of sales and engineering, becomes president of Cutler-Hammer, Inc., succeeding **Mr. Bacon.** Other officers

Tooth Insurance For GEARS

Protection of gearing requires highly effective lubricants. Ordinary gear greases and shields don't protect teeth because they cannot resist the effects of speed and pressure.

NON-FLUID OIL prevents tooth wear because it is so very adhesive that surfaces are kept continuously coated with a tough film of lubricant.

NON-FLUID OIL is not readily affected by temperature changes. Heat will not cause it to drip, nor will it "ball up" and fall off where cold is encountered. Long life assures low lubrication costs.

NON-FLUID OIL is being used successfully in leading iron and steel mills. Send for instructive bulletin.

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TRADE MARK REGISTERED NON-FLUID OIL IN U.S. PAT OFFICE & FOREIGN COUNTRIES

Modern Steel Mill Lubricant

Better Lubrication at Less Cost per Month

elected include **J. C. Wilson,** vice president and secretary, **P. B. Harwood,** vice president in charge of engineering, **P. S. Jones,** vice president in charge of sales, **Philip Ryan,** vice president in charge of manufacturing, **E. W. Seeger,** vice president in charge of development and assistant secretary, **M. R. Fenno,** assistant treasurer, and **J. C. Springer,** assistant secretary.

E. J. Hergenroether, recently resigned chief of the metallurgical branch of the steel division of War Production Board at Washington, D. C., has resumed his duties with the development and research division of The International Nickel Company, Inc., New York. Mr. Hergenroether will be in charge of the Division's automotive steel development and will make his headquarters in Detroit at the company's field office there. He has served with the War Production Board and predecessor agencies, mainly in the steel division, in Washington since May 1941. Previous to this Mr. Hergenroether had been with the Detroit office of the International Nickel Company for twelve years, advising various industries on metallurgical problems. Before joining International Nickel, he was assistant chief metallurgist with the Cadillac Motor Car Company.

Fred M. High, formerly roll engineer for Hyde Park Foundry and Machine Company and Lewis Foundry and Machine, is now associated with the roll sales of Aetna-Standard Engineering Company, Youngstown, Ohio.

Julius E. Graf, assistant chief engineer of the Jones and Laughlin Steel Corporation has taken up duties as chief engineer of the metallurgical branch of the economic division of the United States Government Control Commission for Germany, which is headed by **R. J. Wysor,** former president of Republic Steel Corporation.

Mr. Graf will have the assimilated rank of colonel in the U. S. Army and will be responsible for the engineering work of the control commission which is charged with the task of reconverting Germany's steel and other metal producing industries to peacetime production.

Mr. Graf's entire business experience has been in heavy industry engineering work. He has been with Jones and Laughlin in his present capacity since 1940 having come to them from the Treadwell Engineering Company of Easton, Pa. where he has been vice president in charge of engineering. Prior to that he had been chief engineer of the American Sheet and Tin Plate Company until its merger with Carnegie-Illinois Steel Corporation when he was made assistant chief engineer of that company.

Albert L. Kaye has been appointed metallurgical engineer for alloy steel products in the Pittsburgh district of Carnegie-Illinois Steel Corporation. He succeeds **John Mitchell,** recently appointed manager of the products section of the company's alloy sales division.

Mr. Kaye is a graduate of Massachusetts Institute of Technology in 1934, where he received his bachelors, masters and doctors degrees in science (electro-chemical engineering). He held the Gerrard Swope Fellowship in physics at M.I.T. and also held a teaching fellowship in

chemistry at the California Institute of Technology. He first became associated with Carnegie-Illinois in 1936.

Maurice J. Day has been appointed to succeed Mr. Kaye as manager of the alloy bureau in the Carnegie-Illinois metallurgical division, Chicago. Mr. Day has been with the company since 1937 and is a native of Saginaw, Michigan.

David F. Austin, vice president in charge of sales of Carnegie-Illinois Steel Corporation, has been appointed acting vice president, sales, of United States Steel Corporation of Delaware, assuming the duties of **Avery C. Adams,** who recently resigned.

LEO F. McCAFFREY

Leo F. McCaffrey has joined the Allis-Chalmers Manufacturing Company as an industrial engineering specialist, heading the metal industries activities of the industrial sales department. Prior to joining Allis-Chalmers, he served as assistant works manager in charge of operation at the Algoma Steel Company, Ontario, Canada. A graduate of Carnegie Institute of Technology, Mr. McCaffrey has been employed by Jones and Laughlin Steel Company, Crucible Steel Company of Midland, Pa., Weirton Steel Company of Weirton, West Virginia, the Otis Steel Company, Cleveland, Ohio and the Ford Motor Company. He has also served as a special consultant to the operating vice president of the Steel Company of Canada.

Robert M. Honegger has been made general manager of the Farrel-Birmingham Company, Inc., gear plant at Buffalo, New York.

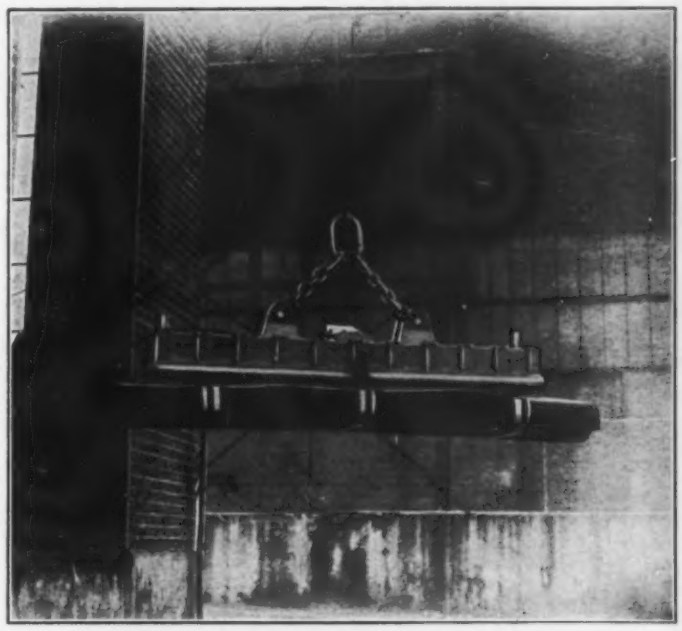
Mr. Honegger received both his early and technical education in his home city of Buffalo and first became associated with the Farrel organization in 1925 as a member of the engineering department. In 1935 he was made general foreman and shortly after became plant superintendent, which position he held until the present appointment.

Mr. Honegger, in his present capacity, succeeds **Lester D. Chirgwin,** formerly of Buffalo and now of

(*Please turn to page 130*)

The

Fastest Method



of loading or unloading and handling bundles of iron or steel sheets, by the use of Ohio Electric Lifting Magnet, is shown above.

One man can do the job in 1/3 the time and not one sheet is damaged.

You can save 6 cents per ton, handling cost, by this means.

Can you afford to pass up this opportunity to save time and money?

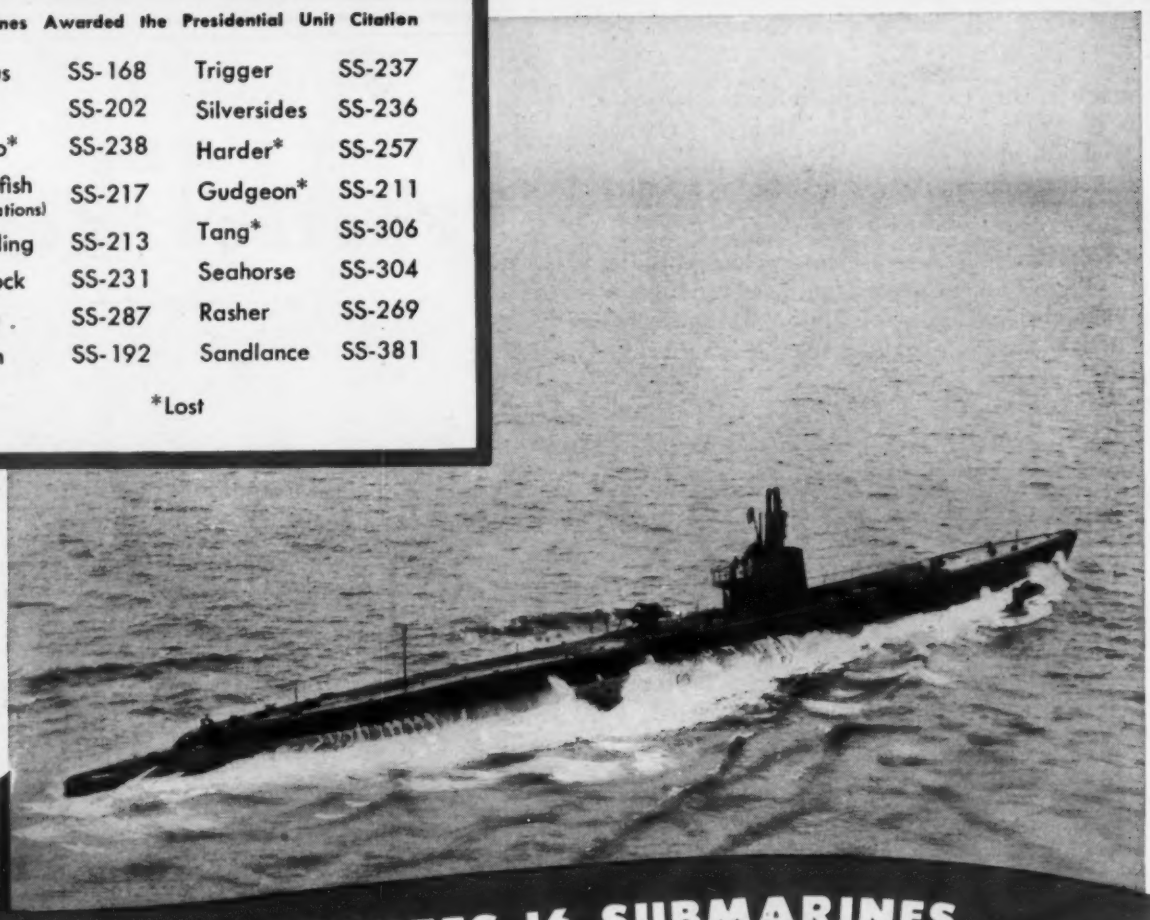
ask

THE OHIO ELECTRIC MFG. CO.

5907 BELLFORD AVENUE
CLEVELAND 4, OHIO

Submarines Awarded the Presidential Unit Citation			
Nautilus	SS-168	Trigger	SS-237
Trout*	SS-202	Silversides	SS-236
Wahoo*	SS-238	Harder*	SS-257
Guardfish (two citations)	SS-217	Gudgeon*	SS-211
Greenling	SS-213	Tang*	SS-306
Haddock	SS-231	Seahorse	SS-304
Bowfin	SS-287	Rasher	SS-269
Sailfish	SS-192	Sandlance	SS-381

*Lost



EXIDE SALUTES 16 SUBMARINES

Honored by the Presidential Unit Citation

AS this is written, sixteen U. S. submarines have won the highest honor which can be awarded to a unit of our armed forces. Their achievements stand out among the proudest in American naval history. And the complete story is still to be told.

Ranging incredible distances, often to within gunshot of enemy shores, they have helped to swell the total of submarine-destroyed Japanese vessels to more than 1000—seriously crippling vital supply lines, and preparing the way for the great naval victories that followed.

Their phenomenal successes are a result of superb skill and a brave fighting spirit. As we salute these heroic ships, we take great pride in the knowledge that all but one of them was powered by Exide Ironclad Batteries.

The same type of Exide Ironclad Batteries used to propel a 2000-ton submarine also furnishes motive power for the efficient, time-saving, electric industrial truck—the modern, economical method of materials handling. And wherever they serve, Exides are performing with dependability, long-life and ease of maintenance.

Write us for a FREE copy of the bulletin "Unit Loads," prepared by The Electric Industrial Truck Association. It tells how to cut handling costs up to 50% . . . covers latest developments in materials handling . . . and includes actual case histories.

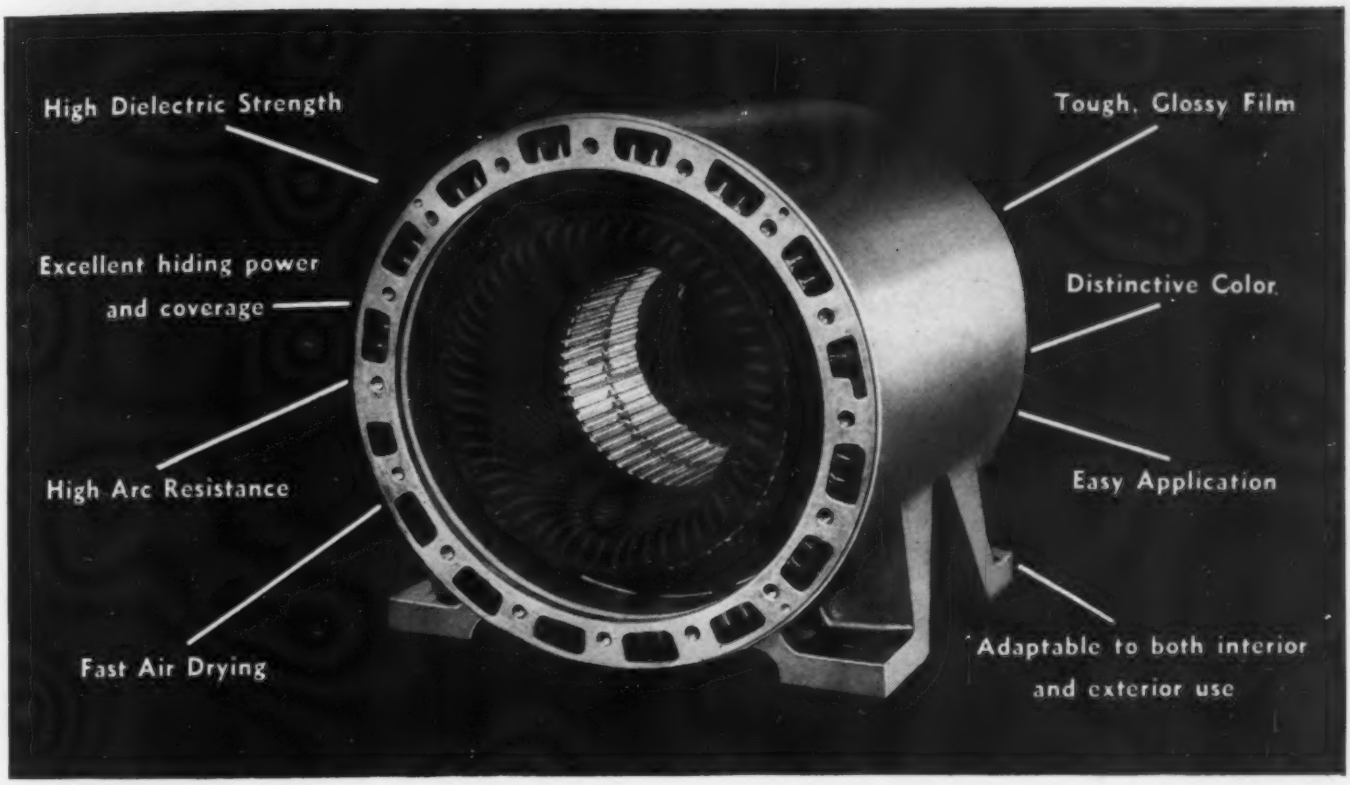
ARMY E NAVY

Exide
BATTERIES

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 32

Exide Batteries of Canada, Limited, Toronto

Protection DOLPH'S #10 RED INSULATOR



Illustration—Stator of Continental Electric Explosion-proof Motor

"WET DIELECTRIC UNCHANGED AFTER 3500 HOURS OF HEAT-AGING AT 275°F."

Yes, * SYNTHITE #10 Red Insulator was actually subjected to this severe test and passed it with "flying colors." SYNTHITE #10 Red Insulator was applied over two coats of clear baking varnish on a brass surface, and HEAT-AGED FOR 3500 HOURS AT 275°F. After this period, the test specimens were immersed in distilled water for 24 hours. The wet dielectric strength of the varnish after this treatment did not vary materially from the wet dielectric determined before the test, and the varnish film was in good condition.

Applied by brush or spraying over prevarnished surfaces, SYNTHITE #10 Red Insulator affords maximum protection against chemical fumes, oil, water, acids and alkalies. In fact, the chemical resistance of SYNTHITE #10 is so great that engineering departments of various industries such as paper mills, refineries, cement plants, copper mines, coal mines, quarries and steel mills, are using this enamel for protection against chemical fumes.

Insulating Dolph's Varnish Specialists

JOHN C. DOLPH COMPANY

168 EMMETT STREET • NEWARK 5, N. J.

* Reg. U. S. Pat. Off.

Ansonia, Connecticut. In March 1945, Mr. Chirgwin was elected vice president in charge of manufacturing in all four Farrel-Birmingham plants located at Ansonia, Derby and Stonington, Connecticut, and Buffalo, New York.

Charles A. Butcher, formerly manager of the Pacific Coast manufacturing and repair department of the Westinghouse Electric and Manufacturing Company, Oakland, California, has been recently appointed assistant general manager of the Crocker-Wheeler Division, Joshua Hendy Iron Works, Ampere, New Jersey.

Following his early electrical experience with the Des Moines City Railway Company, Mr. Butcher joined Westinghouse and was employed, successively, in Chicago district sales, East Pittsburgh design engineering and general engineering, followed by service as eastern district engineering manager and eastern district service manager, manager of eastern manufacturing and repair department, assistant manager of manufacturing and repair department at East Pittsburgh, and manager of Pacific Coast manufacturing and repair department

Mr. Butcher is a native of Des Moines, Iowa and graduated from Iowa State College with the degree of B.S. in Electrical Engineering.

Robert Wier, Jr., has been appointed general sales manager of the brush division of the Osborn Manufacturing Company, of Cleveland, Ohio.

Mr. Wier, a native of Wilmington, Delaware, brings to Osborn a background of engineering and sales experience gained over a period of nearly 30 years in the chemical, oil and ammunition industries following his graduation from Sheffield Scientific School of Yale University in 1918. He was formerly sales manager of the Western Cartridge Company with headquarters at the Winchester Repeating Arms Company division in New Haven, Connecticut, and prior to that was vice president and general manager of the Hearn Oil Company, subsidiary of the Sun Oil Company.

George H. Dowding has been made director of industrial relations for the Chicago district of Carnegie-Illinois Steel Corporation, succeeding **Peter V. Martin,** who leaves the company for assignment abroad with the Foreign Economic Control Council.

Mr. Dowding has been associated with the company since January 1919. He held various positions in Gary and South Chicago plants of the company before becoming superintendent of industrial relations at the latter plant four years ago.

Earl H. Fyler, formerly assistant to the Chicago district director of industrial relations, has been appointed to succeed Mr. Dowding at the South Chicago plant. Mr. Fyler has been associated with the company in Gary and Chicago for the last 15 years. His position on the district industrial relations staff is being taken by **Nathan Weston,** formerly on the staff of the vice president of industrial relations in Pittsburgh.

Walter F. Munford has been named assistant vice-president of the American Steel and Wire Company, subsidiary of U. S. Steel Corporation.

A graduate of Massachusetts Institute of Technology, Mr. Munford has worked his way up through the ranks and brings to his new position a wide background of experience. For three years he was superintendent of the open hearth department at Newburgh Steel Works in Cleveland before being transferred to the National Tube Company, another U. S. Steel subsidiary, as assistant superintendent of the steel works at Lorain, Ohio, in 1933. He then returned to the Wire Company as assistant superintendent of Cuyahoga Works, Cleveland, and in 1937, he was promoted to superintendent of that plant. He was next moved up to the post of assistant to vice-president, operations, and later transferred to Pittsburgh, Pennsylvania, as assistant manager of operations. Mr. Munford has been manager of operations at Worcester since April, 1942.

George A. Gleason has been made manager of operations of the Worcester, Massachusetts, district, succeeding Mr. Munford. Mr. Gleason was formerly general superintendent of the company's South Works in Worcester.

Born in Worcester on July 29, 1890, Mr. Gleason was educated in the public schools of that city and Holden, Massachusetts, and was graduated from Georgia Technical Institute with a B. S. degree in civil engineering. His first employment with American Steel and Wire was in March, 1917, when he was made a draftsman at Worcester South Works. He held a succession of other positions before being made assistant superintendent at South Works in February, 1930. In December, 1939, he became general superintendent of that plant.

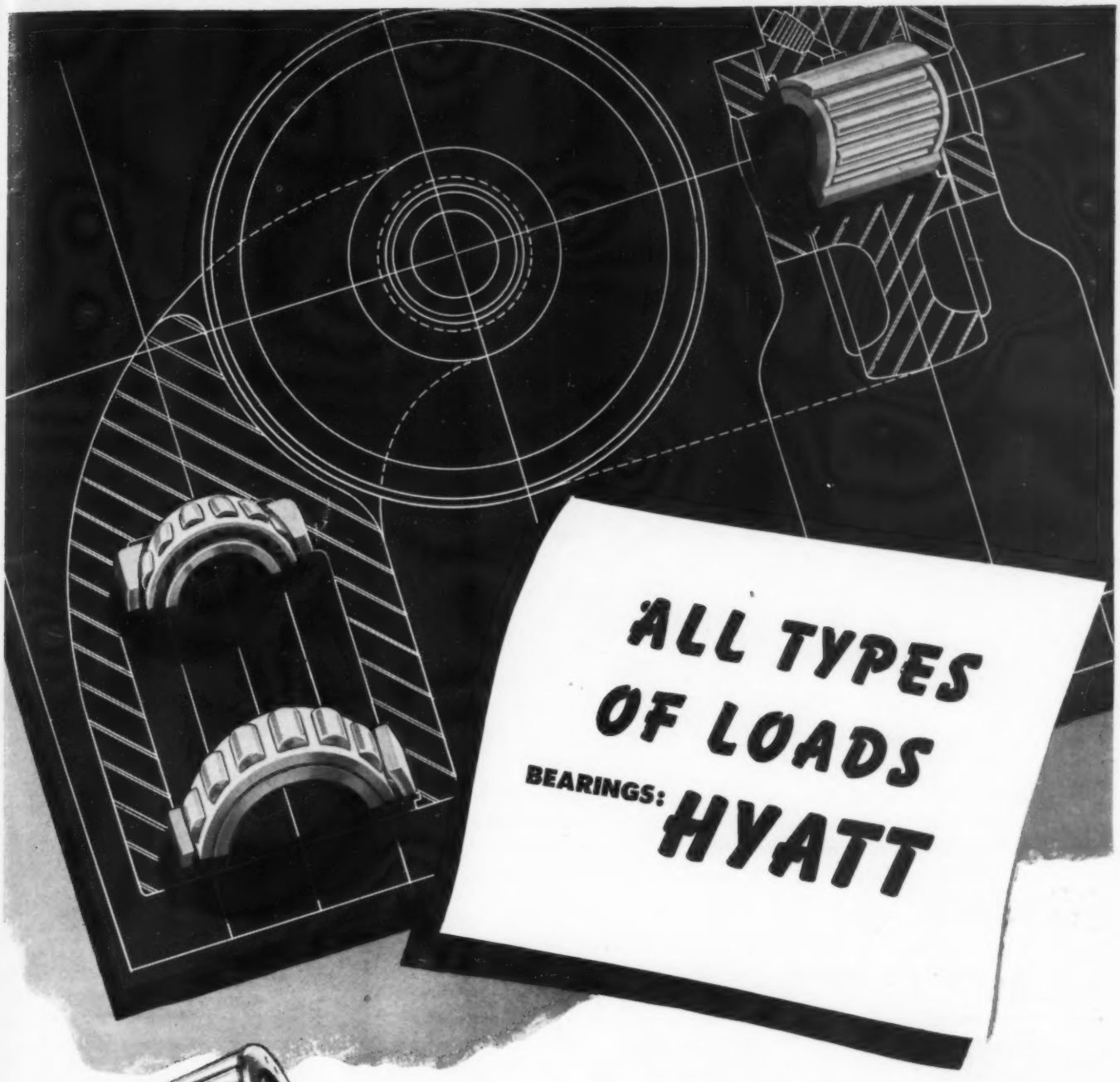
IMO pump circulating governor oil and lubricating oil for large turbine.

The IMO PUMP requires less space than most other pumps because of the high capacity attainable by its efficient, compact design and high speed operation. If desired, it can be directly connected to, and mounted upon, turbines, motors, engines, or other equipment. In special designs, dimensions and proportions can be varied to meet space limitations. I-128

For further information write for Catalog I-128-I

IMO PUMP DIVISION OF THE DE LAVAL STEAM TURBINE CO. TRENTON 2, NEW JERSEY

IMO MOVES OIL



Representative of how Hyatt Roller Bearings meet specific application requirements is the plate caster assembly in which there are three types of Hyatts, each doing its allotted job.

Minimizing friction and assuring freedom from wear, is a sturdy Hyatt Junior Series Solid Roller Type Bearing in the wheel hub. Contributing to free turning of the gooseneck and applied at its top, is a Hyatt Spherangular Bearing, self-aligning and suitably designed to carry both radial and thrust loads. At the bottom of the gooseneck is a Hyatt Hy-Load Bearing which provides line contact for better load distribution.

You are invited to call on Hyatt engineers for help with any present or future bearings application problems.

HYATT BEARINGS DIVISION · GENERAL MOTORS CORPORATION

Harrison, New Jersey · Chicago · Detroit · Pittsburgh · Oakland, California

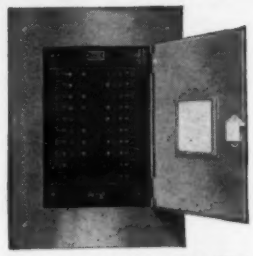
TRUMBULL PANELBOARDS

Remember.... you've got to *live* with your Panelboards!

When you select your Panelboards . . . consider this . . . they'll be on the job for a long time.

These nerve centers of your electrical distribution and control must be selected with foresight, with knowledge of the newest developments, with consideration for convenient renewal of the protective devices, for convertibility, expansion . . . and above all SAFETY to plant, machine and personnel.

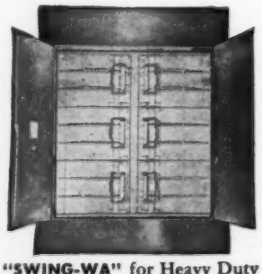
We show here 6 popular Trumbull Panelboard types, each fully described in a Bulletin (as indicated) available on request.



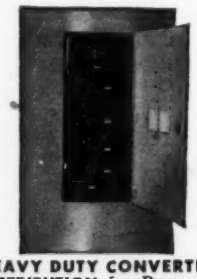
"NAB" CIRCUIT BREAKER, primarily for branch lighting circuits . . . "AT" breaker units for 15 to 50 ampere branches . . . 1-2-3 pole, common trip. High quality circuit breaker protection. Circ. No. 321.

MULTI-BREAKER ("M" and "MB" units) for branch lighting circuits in homes, stores, offices, etc. 15-50 amp. branches. Circuit breaker protection at low cost. Circ. No. 325.

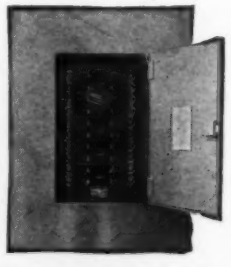
CONVERTI-FUSE for Lighting and Power Distribution . . . extreme flexibility . . . safe fuse replacement *away from panel.* Branch circuits 30 to 400 ampere . . . low cost. Circular No. 306.



"SWING-WA" for Heavy Duty Power and Lighting. Each branch circuit enclosed in steel compartment, 0 to 400 ampere . . . the highest quality Fusible type available. Circular No. 305.



HEAVY DUTY CONVERTIBLE DISTRIBUTION for Power and Lighting. "AT" breaker units for 15-600 amp. branches, 2-3 pole, common trip. Circ. 303. Lower cost panels also in Type MH Multibreaker.



SWITCH & FUSE Lighting Panelboards . . . low cost, compact. Multiple grouping of standard parts. Tumbler switches and fuses in branches . . . 30 amp. max. Circular 326.

THE TRUMBULL ELECTRIC MANUFACTURING CO.

A GENERAL ELECTRIC ORGANIZATION

OTHER FACTORIES AT NORWOOD (CINN.) O.
SEATTLE — SAN FRANCISCO — LOS ANGELES

PLAINVILLE, CONNECTICUT

No matter how you look at MILL MOTORS

You'll See Top Performance with AX5's or SA35's

GO INTO any steel mill today. You'll see excellent mill motors like these . . . giving unprecedented round-the-clock service!

In more and more of such heavy-duty motors, "National" Grade AX5 or Grade SA35 brushes are being installed. Operating men have learned that both of these electro-graphitic brush grades are *strong mechanically* . . . have superior commutating characteristics . . . combine high contact drop with low coefficient of friction . . . and are non-abrasive!

Both grades were developed after thorough studies of load and atmospheric conditions, commutator maintenance problems and many other practical, steel-mill operating factors.

They are but two of a number of carbon, graphite, electro-graphitic and metal-graphite brush grades that National Carbon Company, Inc., has developed to meet the varying needs of every class of rotating electrical equipment . . . from fractional horsepower motors to the largest motors and generators.

The word "National" is a registered trade-mark of National Carbon Company, Inc.

NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide and Carbon Corporation

UCC

General Offices: 30 East 42nd Street, New York 17, N. Y.

Division Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

KEEP YOUR EYE ON THE INFANTRY . . . THE DOUGHBOY DOES IT!

The Pace of Victory Permits Only A Congratulatory Handshake!

American Industry well merits a decoration for its brilliant record in the Mighty 7th! But, as our newly decorated Pacific heroes quickly return to combat, so industrial leaders aren't resting on their laurels. ***Back into Bond action***—they are now busy consolidating recent Payroll Savings Plan gains!

First, many executives are now patriotically working to retain the substantial number of new names recently enrolled during the 7th War Loan. By selective resolicitation, they are urging all new subscribers to maintain Bond buying allotments.

Second, many are also employing selective resolicitation to urge every worker who increased his or her subscription in the 7th to continue on this wise, saving-more-for-the-future basis.

Help to curb inflationary pressures and harvest peacetime prosperity by holding the number of Payroll Savings Plan subscribers—and amounts of individual subscriptions—to the mark set in the Mighty 7th!

The Treasury Department acknowledges with appreciation the publication of this message by

IRON AND STEEL ENGINEER

★ *This is an official U. S. Treasury advertisement prepared under the auspices of Treasury Department and War Advertising Council* ★

NEW TYPE *non-metallic* OIL SEAL

offers 3 proved advantages in steel mill service

One-Piece Precision Molded Body—
highly resistant to grease, oil and many corrosive liquids. Entirely non-metallic—can't score.

Rigid Heel—
made of a dense resin-bonded fabric to insure a press fit in the packing recess.

Flexible Lip—
an integral part of the seal. Makes possible accurate control of pressure against shaft by means of self-adjusting garter spring.

Large Bearing Area—
reduces wear on shaft to a minimum.

Self-Adjusting Garter Spring—
permits accurate control of pressures and provides a positive contact with shaft at all times. Special spring stock is available for extreme corrosive conditions.

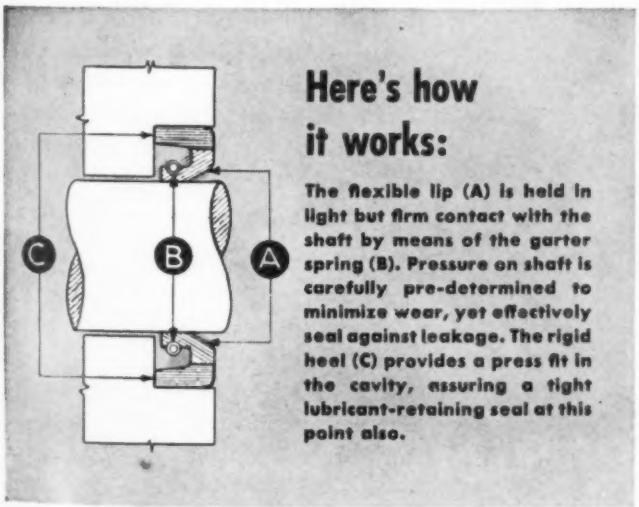
THIS new Johns-Manville "Clipper Seal" was designed to do three things: (1) to provide better bearing protection; (2) to minimize wear on the shaft; and (3) to increase the length of service normally expected of an oil-retaining seal.

Users in the steel industry tell us it has made good on all three of these important counts!

A glance at the illustrations shows why. Note Clipper Seal's one-piece body—concentrically molded for a precision fit. Note how the flexible lip is held in light but firm contact with the shaft, effecting a positive lubricant-retaining, dirt-excluding seal—while at the same time reducing wear on the shaft. And note the unusually large bearing area, which further tends to minimize shaft wear.

Non-metallic in construction, Clipper Seals are highly resistant to most forms of corrosion. Molded of resin-impregnated fabrics and synthetic rubber compounds, they are tough, long-wearing—successfully meet extreme operating conditions. Actual performance experience confirms their ability to outlast other types of bearing protectors in steel mill service.

For further information about Clipper Seals and how they can help reduce bearing maintenance in your plant, write Johns-Manville, 22 East 40th Street, New York 16, N. Y.



Here's how it works:

The flexible lip (A) is held in light but firm contact with the shaft by means of the garter spring (B). Pressure on shaft is carefully pre-determined to minimize wear, yet effectively seal against leakage. The rigid heel (C) provides a press fit in the cavity, assuring a tight lubricant-retaining seal at this point also.

Johns-Manville **PACKINGS & GASKETS**

to prove a point for KEYSTONE End Bells

take a look at the inside of this conventional type END BELL

And the point is this — A sleeve bearing motor, operating in dirt and dust laden air builds up a hard scale on the end bell, commutator and mica cone by mixing dirt with lubricating oil flying from the bearing. This condition cannot exist with a KEYSTONE Grease Packed, Ball Bearing End Bell. There is no oil but permanently lubricating grease firmly sealed in the KEYSTONE End Bell. The maintenance economy — increased service from clean, free running motors is the result of the KEYSTONE installation. May we show you how the motors in your plant can benefit from this economical conversion? Just write or call us.

At far left is the old sleeve bearing motor end bell. To its right is the KEYSTONE. In all cases the KEYSTONE is guaranteed to fit in place on the old motor frame and the old frame bolts will be the right length when used on the new housing.

Bearing Specialists

The OHIO BALL BEARING Co.

BALL-ROLLER and THRUST BEARINGS

HE 6643 6531-33 EUCLID AVENUE • CLEVELAND 3, OHIO

BRANCH OFFICES: Canton, Dayton, Columbus, Akron, Cincinnati, Youngstown, Charleston, Wheeling, Fort Wayne, Indianapolis, Muncie, Terre Haute

CABLE LIFE "PRE-VIEWED" BY YEARS OF EXPOSURE

Okonite's Proving Ground Duplicates Actual Operating Conditions

All kinds of weather and four kinds of soil provide thoroughgoing performance "pre-views" at the cable proving ground at The Okonite Company's Passaic, New Jersey plant.

About to start its ninth year of carefully-recorded cable service studies, this unique *outdoor laboratory* is dedicated to evaluating the useful life of all types of insulation both above and below ground under all severe operating conditions. Believing that time and time alone is the only true means of determining what a cable will do, Okonite engineers put principle into practice with the realistic creation of actual service conditions rather than artificial "accelerated aging".

Buried directly in various types of earth, pulled into conduit or installed overhead — network, control, primary distribution and portable power cables are constantly operating under controlled conditions of temperature, voltage and loading.

At specified intervals they are taken up, sections cut from the cable and detailed tests conducted under the independent supervision of The Electrical Testing Laboratories.

Test Conditions

Cables under test are installed in four concrete troughs, each 50 ft. long by 4 ft. wide and 4 ft. deep. These troughs, open at the bottom, are each filled with a different type of soil:

1. Top soil saturated with corrosive water from a manhole.
2. Soil with a layer of manure over the cables to simulate conditions of decaying organic matter.
3. A mixture of 99 lb. of sand and 1 lb. of lime which is subjected to a periodic pH test and maintained highly alkaline.
4. Soft-coal cinders regularly wet with a sulphuric acid solution to render them positively acid. Given a regular pH test and acidity maintained.

Cables in each trough are in two layers, Spacing of cables was selected to allow control and signal cables to be slightly warmed by network cables which are subjected to current loading. The majority of cables are buried between 30 in. and 36 in. deep.

Buried Since 1937

Four main types of cables are installed in the troughs in the proving ground.

1. Network cables. Nine cables representing all constructions, including fibrous and rubber covered; 250,000 circ. mil. single-conductor, insulated for 600 volts, operating at 120 volts and loaded in cycles nine hours a day, five days a week, to give a copper temperature of approximately 60 deg. C. Network cables in all troughs are in series across 120 volts.
2. Control cables. Eleven seven-conductor, rubber insulated cables with various types of metallic and non-metallic sheaths in each trough energized at 120 volts but not loaded.
3. Underground primary distribution cable. Four different commonly-used types of 5-kv. non-metallic sheath cable in each trough energized at 7.6-kv. but not loaded. Each trough contains 50-ft. lengths of each type of cable.
4. Portable high-voltage cable. Two types, shielded and non-shielded, 12.5-kv. three-conductor, dredge or shovel cables run at random in the yard on the top of the ground and moved each week. Two types are connected in series and ends connected to 12.5-kv. busbars.

In addition to the underground cables, two 30-ft. poles have been erected carrying more than a dozen types of insulated aerial cable and line and tree wire energized at 7.6-kv. from the bus-bar structure. Interconnecting these overhead "circuits" are three conduit risers on each pole containing four test cables each.

As tests are tabulated, valuable trends have already been disclosed. While eight years are too short for final conclusions, proving-ground results have indicated significant tendencies. For example, in the case of exposed cables, Okolite-Okoprene (Patent 2,312,058) is showing to advantage over the fibrous type of rubber insulated cable which has suffered braid deterioration, tape erosion and corona cutting.

This is but one instance — one forerunner of benefits to come. As time goes on and more and more facts accumulate, Okonite engineers will be guided to a greater degree by this recorded test data, and will pass along greater service-life knowledge in the form of improved electrical wires and cables. The Okonite Company, Passaic, New Jersey.

Underground portion of proving ground at end of first full year of operation.

Cables are periodically exhumed, sections removed, ends sealed for reburial.

OKONITE insulated wires and cables
4124

GRAPHITE GUS SAYS:

GRAPHITE THRIVES ON HEAT AND PRESSURE

... that's why DIXON'S GRAPHITE ROLL NECK GREASES Cut Wear, lessen machining, save "down" time and power costs

These special made-for-the-purpose roll neck greases stand up where ordinary greases fall down. The lubricating graphite in them will not squeeze out and is virtually immune to heat. They lessen repairs and replacements. Dixon's Graphited Roll Neck Greases lubricate longer—and reduce power costs. Get them for your roll necks—and any other spot where you fight extreme heats and pressures. Send for folder "ROLL NECK LUBRICATION."

JOSEPH DIXON CRUCIBLE COMPANY

Div. 18c 7 JERSEY CITY 3, NEW JERSEY

NATURALS FOR "HOT SPOTS"

DIXON'S LUBRICATING FLAKE GRAPHITES... All screen sizes. To apply dry, or to fortify oils and greases, and to coat pipe joints and gaskets. Data Sheets Nos. 5, 6, 7 tell the uses.

DIXON'S GRAPH-AIR GUN, Filled with Microfyne Graphite... A dry graphite ejector to lubricate hard-to-reach mechanisms, locks, jigs, tools. Data Sheet #8 gives details of this effective little lubricator.

DIXON'S GRAPHITE SLIPSTIK... This wax-like lubricating stick is used like a crayon for fast rub-on lubrication. Data Sheet #23 tells why it is indispensable for certain uses.

DIXON'S GRAPHITED OILS AND GREASES... Ready-to-use, fortified with Dixon's lubricating flake graphite, provide sustained lubrication for longer periods, especially under extremes of heat and pressure. Data Sheets #13 & 14 tell about Cup Grease and No. 677.

Write Graphite Gus for any of above mentioned Data Sheets and the Directory listing 11 other friction-fighting graphite products.

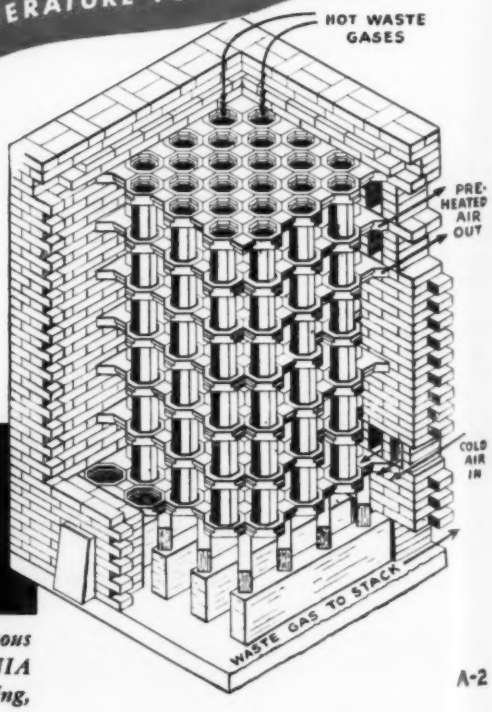
AMCO Recuperator

THE IDEAL HEAT EXCHANGER FOR HIGH TEMPERATURE FURNACE OPERATION

The AMCO Recuperator is the result of years of research to develop the one essential factor for steel mill service . . sturdy reliability in construction without the sacrifice of economy in heating practice.

Among its distinctive features are: (1) the simultaneous entry of all waste gases into vertical tubes with immediate transfer of heat to all of the air being preheated; (2) all joints are horizontal and automatically sealed against leakage by weight of tube assembly; (3) spacing of the vertical flues to insure uniform heat transfer; (4) their obvious benefits can be realized when used with any high temperature furnace.

Write for further information



AMSLER-MORTON

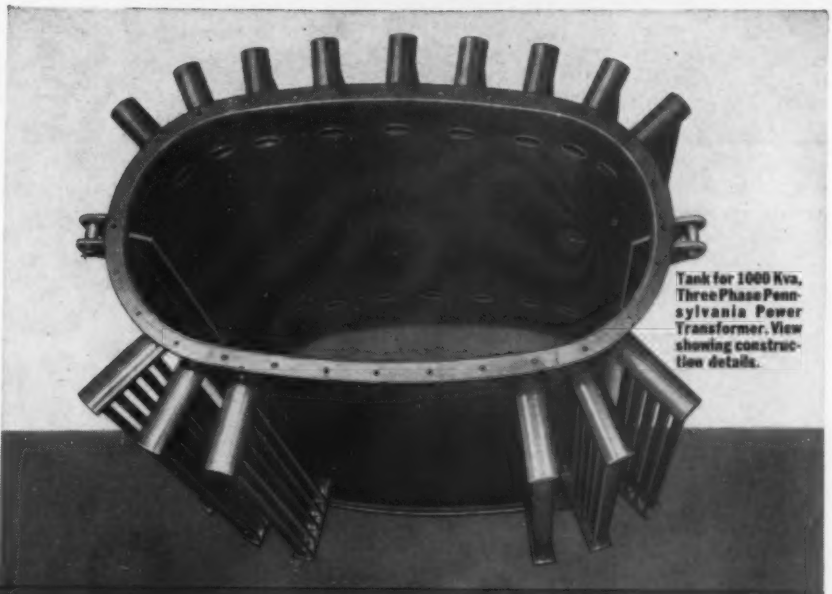
Division of Union Industries, Inc.

Fulton Bldg., Pittsburgh 22, Pa.

A-2

For information on Car-Type, Forge, Tube Normalizing, Heat-Treating, Continuous Conveyor, Galvanizing or Pit Annealing Furnaces . . . write to PENNSYLVANIA INDUSTRIAL ENGINEERS Division of Union Industries, Inc., Fulton Building, Pittsburgh 22, Pa.

Pennsylvania POWER TRANSFORMERS



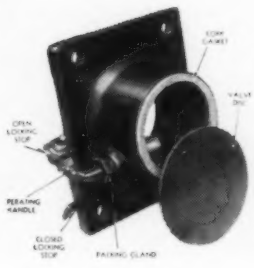
Tank for 1000 Kva, Three Phase Pennsylvania Power Transformer. View showing construction details.

NOTE THESE

TANK and RADIATOR Construction Features

Tank Base showing welded steel

Detachable Radiator.



Radiator Valve.

THEY ASSURE . . .

- RELIABILITY
- LOW MAINTENANCE COSTS
- LONG SERVICE LIFE

1. PENNSYLVANIA POWER TRANSFORMER TANKS AND COVERS are fabricated of heavy copper-bearing steel plate, all seams arc welded with coated electrodes according to the latest standards of the American Welding Society.

2. COVERS are provided with an opening permitting access to the terminal board and to the lower end of the bushings. By means of lugs welded to the cover and an angle structure, the cover may be handled separately or as a unit with core and coil assembly.

3. LIFT LUGS, welded to the tank, are provided for handling the complete transformer with cable slings, chains or hooks.

4. GUIDE BARS, welded to the sides of the tank, extend vertically from top to bottom, permitting the core and coils to be guided into the tank and properly centered by means of guide plates on the core clamping frames, which engage the guide bars.

5. TANK BASES constructed of heavy structural steel shapes welded together and to the bottom of the tank, permit the transformer to be rolled in any direction desired.

6. PENNSYLVANIA UNI-ROW RADIATORS consist of a single row of heavy gauge oval tubes, welded externally to an oval header at the top and bottom. The radiators, which are as ruggedly constructed as the tank, have a uniform cross-section throughout their length and are tested at a pressure of 100 pounds per square inch. They are spaced to readily permit shotblasting, cleaning and painting, by either brush or spray, in factory or field. The oval shape of the headers and the absence of crevices, prevent moisture from lodging on the headers and tubes. Radiators may be either permanently welded to the tank or detachable. Larger transformers are equipped with detachable radiators which may be removed to conform to shipping clearances. Transformers thus equipped are furnished with valves which permit removal of the radiators without draining oil from the transformer. Plugs and air vents are provided on each radiator for filling and draining. Detachable type radiators have lift lugs to facilitate handling.

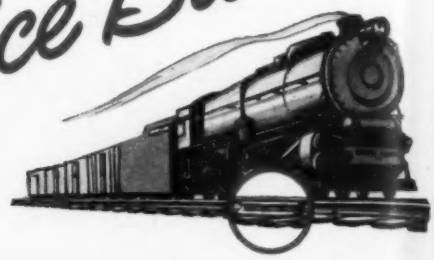
7. SHOT BLASTING is used to clean the surface of the tank, cover and tubes, and all exposed outside surfaces are painted with one priming and two finishing coats of special, approved transformer paint.

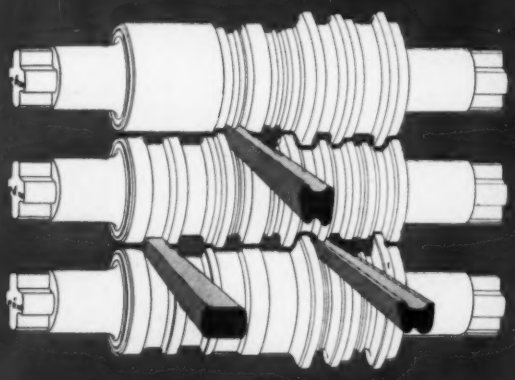
Pennsylvania TRANSFORMER COMPANY

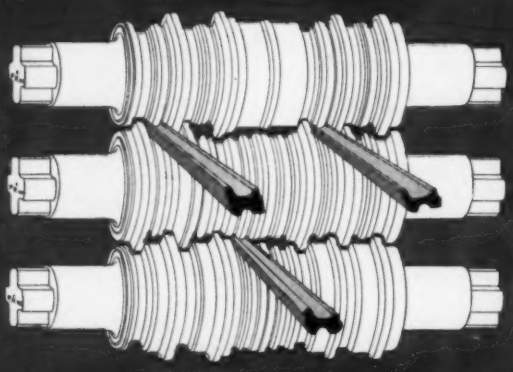
808 Ridge Avenue N. S., Pittsburgh 12, Pa.

ROLLING TECHNIQUE. . .

Splice Bars

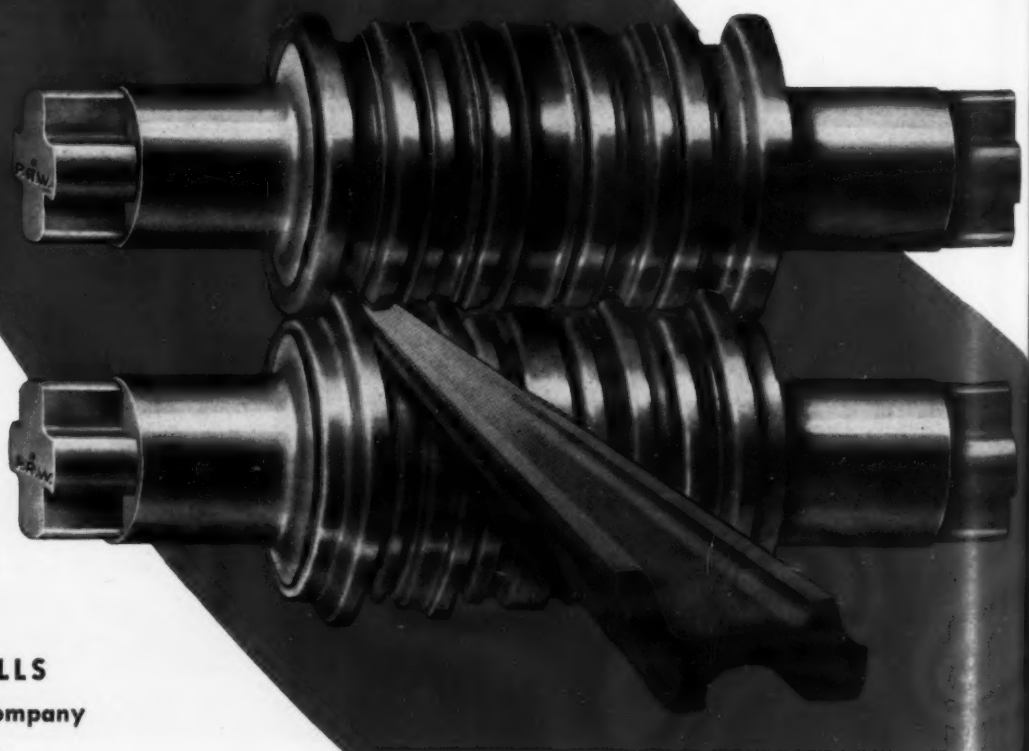






The thousands of miles of rails that make up the numerous networks of railroads throughout the world, require many, many tons of splice bars to join and hold these rails rigid and in perfect alignment. This makes it possible to carry our modern high speed trains loaded to capacity with essential travelers and critical materials of war quickly and safely to their destinations.

Pittsburgh Rolls, with three-quarters of a century of roll-making experience and satisfactory performance behind them, can be relied on to deliver the production of highest quality for which high speed modern mills are designed *at less cost per ton of steel rolled.*

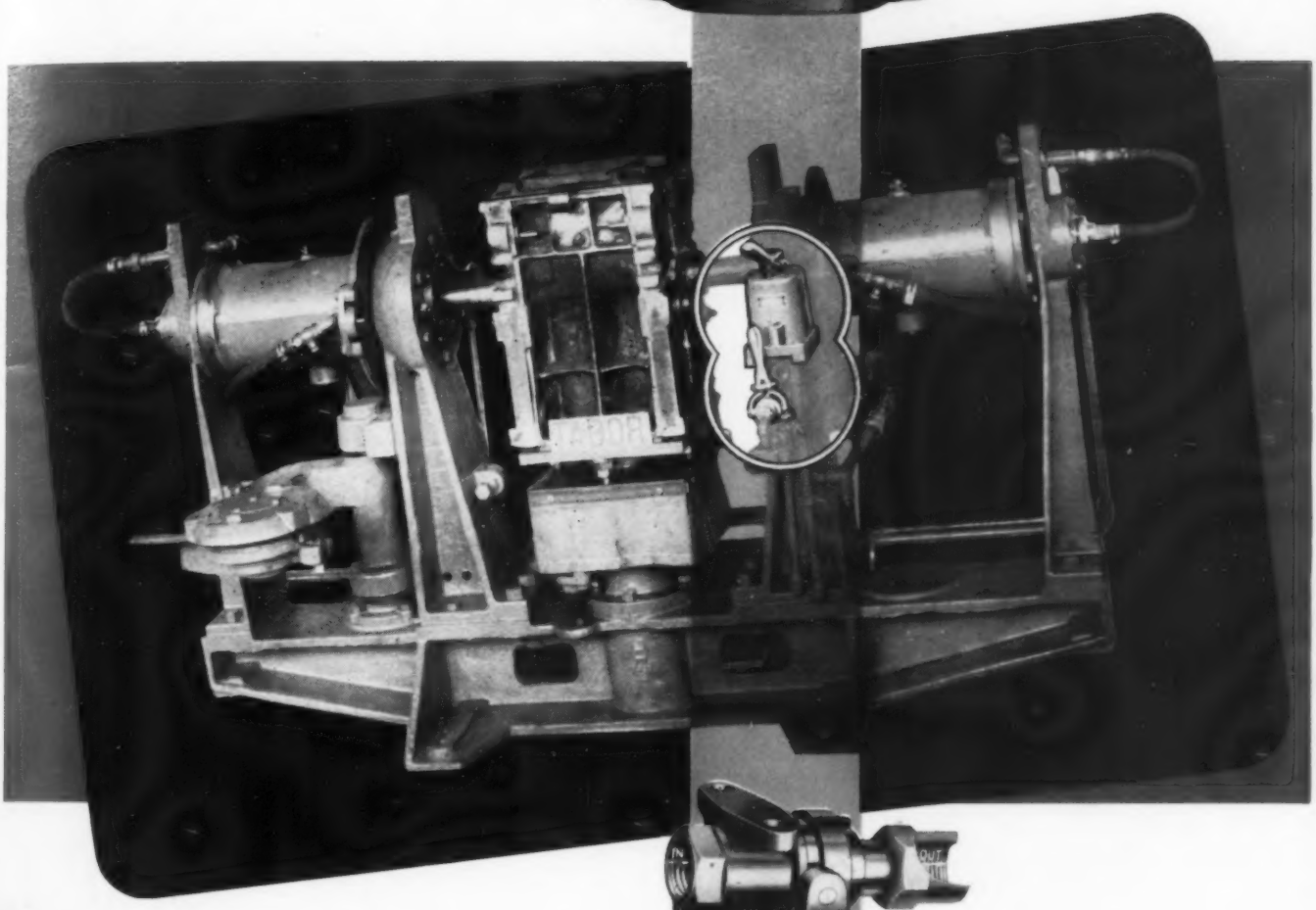


PITTSBURGH ROLLS
75 YEARS EXPERIENCE
1870 1945

PITTSBURGH ROLLS
Division of Blaw-Knox Company
PITTSBURGH, PA.

PITTSBURGH ROLLS

Quick-As-Wink



On automobile core machines, positive control is essential.

The Quick-As-Wink hand operated 4-way compound exhaust valve controls the inner and outer movement of the two horizontal cylinders. The hand-operated 3-way Quick-As-Wink valve controls the upward movement of the center vertical cylinder.

C. B. Hunt & Son manufactures solenoid, hand, foot, and diaphragm operated valves for air, also hand and pilot operated hydraulic types for water or oil applications up to pressures of 5,000 pounds, in standard and special sizes.

This automobile core machine is a product of The Tabor Manufacturing Company, Philadelphia, Pa. Two Quick-As-Wink valves assure positive air control.

The Hunt catalog carries complete, easy-to-use engineering data. Write for a copy.

THE HIGHER THE PRESSURE
AIR
WATER
OIL
THE TIGHTER THE SEAL

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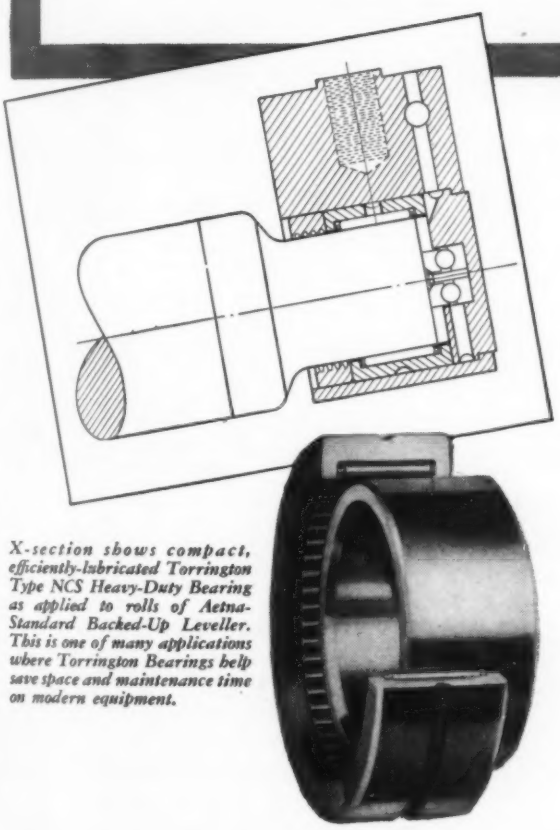

X-section shows compact, efficiently-lubricated Torrington Type NCS Heavy-Duty Bearing as applied to rolls of Aetna-Standard Backed-Up Leveller. This is one of many applications where Torrington Bearings help save space and maintenance time on modern equipment.

Because they combine compactness and high capacity with ease of lubrication, Torrington Type NCS Heavy-Duty Needle Bearings are first choice of designers for such equipment as roll levellers for straightening and restoring ductility to sheet metal. The model shown above has 57 rolls turning smoothly on 114 of these light, sturdy bearings.

In addition to standard Type NCS Needle Bearings, Torrington's Bantam Bearings Division designs and builds large, heavy-duty bearings for roll necks, screw downs, edgers, shears, pinion stands, strip reels, and other steel mill equipment. Our engineers invite consultation on any anti-friction problem, routine or unusual.

THE TORRINGTON COMPANY · BANTAM BEARINGS DIVISION
SOUTH BEND 21, INDIANA

TORRINGTON BEARINGS

STRAIGHT ROLLER • TAPERED ROLLER • NEEDLE • BALL

ONE OPERATOR USING AN ELECTRIC PROPELLED TRANSPORTER DOES WORK OF THREE MEN HANDLING MATERIALS THE OLD FASHIONED WAY..

Now there is

No Straining • No Pulling • No Tugging • No Pushing

Realizing the need for increased production, Frankel Brothers Limited, one of Canada's leading industrial companies in the smelting and refining of secondary metals, included battery-powered TRANSPORTERS for their handling requirements.

In this type of business, where accuracy, speed, and uniform production are necessary, streamlined, sturdily-built, cost-saving, and safe TRANSPORTERS, with their trouble-free operation have been a real assistance in helping to turn out more war essentials.

The TRANSPORTER in an exceptionally wide variety of applications, demonstrates its flexibility, its ability to work in small areas, its ease of handling, and its advantages in moving greater tonnages speedily with safety and with the elimination of unnecessary handling.

• *Send for Bulletins featuring other installations*

We have a number of bulletins available, each featuring the TRANSPORTER at work in a different industry and pointing out the savings made.

ABOVE: *Metal being transported to its proper place in the store room.*

LEFT: *Heavy loads of metal are easily maneuvered with the Electric-Propelled* **TRANSPORTER.**

- **Positive Mechanical Brake with emergency Control**
- **Controls in Steering Handle**
- **Forward and Reverse Speeds**
- **Front Wheel Power Drive**
- **Shockless Hydraulic Platform Lift with Easy Foot Control**

MANUFACTURERS FOR OVER 38 YEARS *Electric Propelled* INDUSTRIAL TRUCKS

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MEMBER OF ELECTRIC INDUSTRIAL TRUCK ASSN.
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AUTOMATIC TRANSPORTATION CO.
47 WEST 87th STREET CHICAGO 20, ILL.
Division of the Yale & Towne Manufacturing Company

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Annual Fall Program

ASSOCIATION OF IRON AND STEEL ENGINEERS

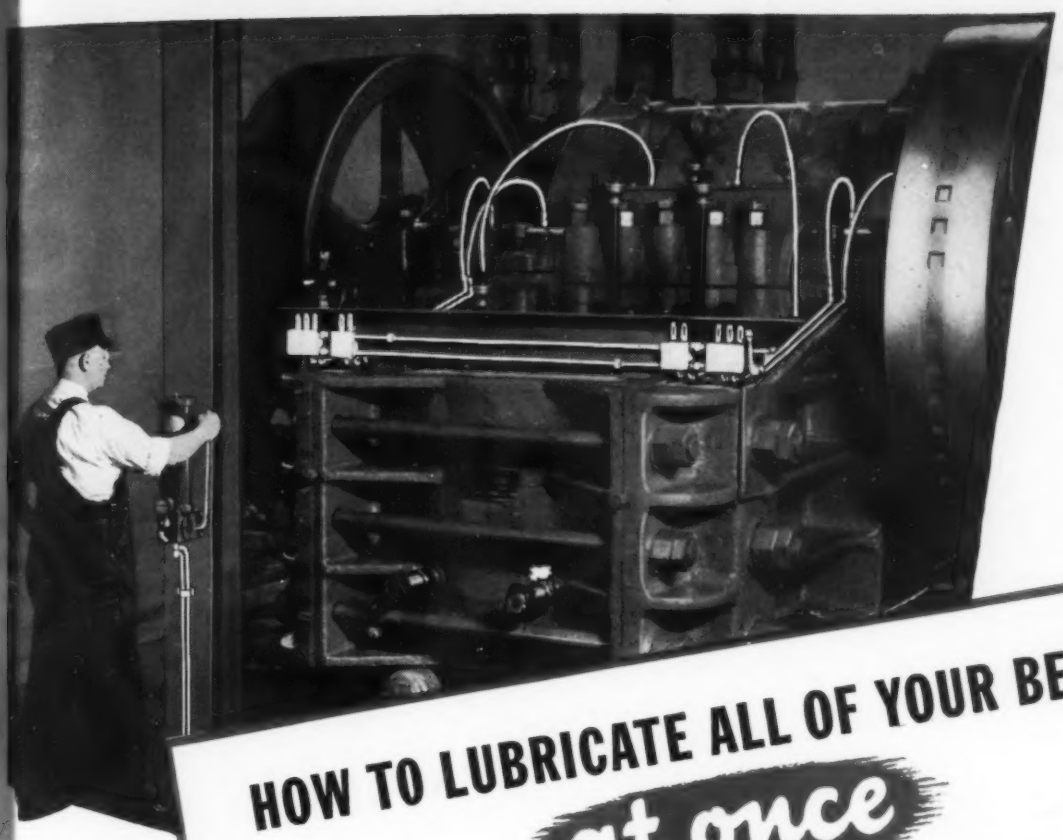
Because of travel restrictions the annual fall program of the Association of Iron and Steel Engineers has been divided into one-day district section meetings as follows:

BIRMINGHAM	SEPTEMBER 17
DETROIT	SEPTEMBER 24
PITTSBURGH	SEPTEMBER 26
CHICAGO	OCTOBER 1
CLEVELAND	OCTOBER 3
PHILADELPHIA	OCTOBER 6

Details will be announced later.

Publication dates of the IRON AND STEEL DAILY NEWS will be September 26, October 1, 6 and 9.

LOOK FOR COMPLETE PROGRAM IN NEXT ISSUE OF IRON AND STEEL ENGINEER



"Birdsboro"
36" x 42"
Jaw Crusher

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and cut oil consumption from gallons to pints

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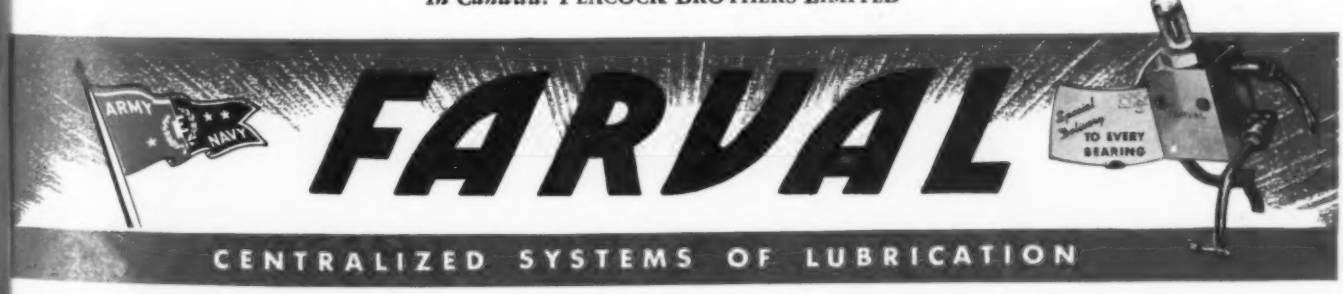

Electronic REEL DRIVE

Gilmore Wire Rope Division,
Jones & Laughlin Steel Corp.,
Muncy, Pa.

Floor space as well as time is saved by these three Thy-mo-trol driven rewinding lines. Note convenient push-button locations with the electronic control panels overhead.

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At this mill, each wire-rewinding line does the work of three, because Thy-mo-trol drive maintains constant and maximum winding speed throughout the winding operation. The rpm of the bobbin, or reel, motor is now automatically changed to allow for coil "build-up", and the wire travels at constant speed in the 1500 to 2000 fpm range.

Furthermore, because the tension is held uniform throughout the winding operation, more evenly wound coils are produced than when a mechanically controlled group drive was used. The reels can be unwound at high speed, without breakage.

OPERATES FROM A-C POWER

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Thy-mo-trol drive is a co-ordinated set of equipment, including d-c motor, electronic panel, transformer, and control station. G-E engineers will help you select and apply Thy-mo-trol drives to your machines, or explore their suitability for new functions. Ask for Bulletin GEA-4025. *General Electric Company, Schenectady 5, N. Y.*

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